

DIABETIC CORONARY HEART PATIENTS' ADHERENCE TO CARDIAC REHABILITATION PROGRAMS

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University of Pittsburgh, 2011

Background: Enrollment in cardiac rehabilitation programs (CR) is used to help patients with coronary artery disease alone (CAD) and diabetes mellitus plus coronary artery disease (T2DM+CAD) regain function after coronary artery bypass grafting (CABG), but T2DM+CAD patients show less functional improvement and lower CR adherence for unknown reasons. The “Patient-by-Treatment Context Interaction in Disease Model” may provide a framework for explaining how disease and intrapersonal factors impact outcomes of these patients.

Objective: To explore potential differences in patient profiles and illness contextual factors between CAD and T2DM+CAD subjects at CR entry, and in adherence and outcomes at CR conclusion.

Methods: This prospective descriptive pilot study recruited 51 CR subjects (27 CAD; 24 T2DM+CAD) and measured patient profiles (socio-demographics, personality traits, locus of control, coping, social support, exercise efficacy) and illness contextual factors (specific disease stage, illness severity, treatment complexity, comorbidities) at CR entry, and appointment and medication adherence, functional status and illness severity at CR conclusion, using questionnaires, point-of-care testing, and medical record information.

Results: There were no statistically significant differences in patient profiles and illness contextual factors between the CAD and T2DM+CAD cohorts, but there were clinically meaningful trends regarding age and gender (T2DM+CAD younger and more female), profiles

(CAD more conscientious; T2DM+CAD more adaptive coping, less exercise efficacy) and illness severity (T2DM+CAD fewer bypasses but lower ejection fraction, many CAD subjects were pre-diabetic). There were no statistically significant differences between cohorts in attendance, medication adherence and functional outcomes at CR conclusion, but the T2DM+CAD cohort reported need for more functional assistance at both time points; neither cohort improved their illness severity.

Conclusions: Although patient profiles and illness contextual factors of CAD and T2DM+CAD subjects in a CR program were statistically similar, some clinically meaningful trends were noted that are worthy of future investigation to inform CR care.

TABLE OF CONTENTS

PREFACE.....	XII
1.0 INTRODUCTION.....	13
1.1 SPECIFIC AIMS	15
1.2 REVIEW OF LITERATURE.....	16
1.2.1 Abstract	16
1.2.2 Prevalence of Type 2 Diabetes Mellitus and Coronary Artery Disease....	17
1.2.3 Review of Literature Method	19
1.2.4 Functional Disability and Type 2 Diabetes Mellitus.....	20
1.2.5 Exercise and T2DM	23
1.2.6 Pathophysiological Patterns with T2DM+CAD.....	25
1.2.7 CR Program Outcomes in Patients with T2DM+CAD	28
1.2.8 Review Limitations and Conclusions.....	33
1.3 CONCEPTUAL FRAMEWORK.....	34
1.4 SIGNIFICANCE OF RESEARCH STUDY FOR NURSING.....	38
1.5 PRELIMINARY WORK	38
2.0 RESEARCH DESIGN AND METHODS	40
2.1 STUDY DESIGN	40
2.1.1 The Patient-by-Treatment Context Interaction in Disease Model.....	40

2.2	STUDY POPULATION	41
2.2.1	Setting and Recruitment	41
2.2.2	Subject Inclusion and Exclusion Criteria.....	42
2.3	STUDY INSTRUMENTS	43
2.3.1	Data Collection Times	43
2.3.2	Data Collection Management	44
2.3.3	Group Designation.....	46
2.3.4	Patient Profiles.....	46
2.3.4.1	Sociodemographic Questionnaire	47
2.3.4.2	Personality Traits: NEO Five Factor Inventory	47
2.3.4.3	Locus of Control: Multidimensional Health Locus of Control.....	47
2.3.4.4	Coping Strategies: Brief Cope Scale.....	48
2.3.4.5	Social Support: Interpersonal Support Evaluation List	49
2.3.4.6	Exercise Efficacy: Therapeutic Self-Efficacy for Exercise Scale....	49
2.3.5	Illness Contextual Factors	50
2.3.5.1	Coronary Artery Disease Stage	50
2.3.5.2	Illness Severity Levels.....	51
2.3.5.3	Treatment Regimen Complexity.....	52
2.3.5.4	Comorbidities	52
2.3.6	CR Program Adherence and Outcomes	53
2.3.6.1	CR Program Adherence	53
2.3.6.2	CR Program Outcomes	53
2.3.6.3	Functional Status Outcomes	53

2.3.6.4	Illness Severity Change Outcomes.....	54
3.0	DATA MANAGEMENT AND STATISTICAL ANALYSES	55
3.1	DATA ANALYSIS FOR SPECIFIC AIMS 1, 2 & 3.....	55
3.2	DATA ANALYSIS FOR SPECIFIC AIM 4	56
4.0	HUMAN SUBJECT RESEARCH.....	57
4.1	RESPONSIBLE CONDUCT OF RESEARCH	57
4.2	INFORMED CONSENT AND THE IRB.....	58
4.3	PROTECTION OF HUMAN SUBJECTS	59
4.4	WOMEN, MINORITY AND CHILDREN INCLUSION IN RESEARCH.	60
4.5	DATA SAFETY AND MONITORING PLAN	60
5.0	RESEARCH RESULTS AND DISCUSSION: SPECIFIC AIMS 1-3	61
5.1	PATIENT PROFILE RESULTS.....	61
5.1.1	Patient Sociodemographic Results.....	61
5.1.2	Pre Rehabilitation Program Clinical Characteristics Results.....	62
5.1.3	Patient Profiles Characteristics Results	63
5.2	ILLNESS SEVERITY MARKERS.....	64
5.3	PROGRAM ADHERENCE AND OUTCOMES.....	64
5.3.1	Program Appointment and Medication Adherence.....	64
5.3.2	Functional Status Results.....	65
5.4	DISCUSSION.....	65
5.5	LIMITATIONS.....	70
5.6	CONCLUSION	70
5.7	TABLES 2 TO 6.....	71

6.0	RESEARCH RESULTS AND DISCUSSION: SPECIFIC AIM 4.....	77
6.1	SPECIFIC AIM 4 PROGRESS AND COMMITTEE DECISION.....	77
	APPENDIX A: REVIEW OF LITERATURE.....	79
	APPENDIX B: IRB APPROVAL LETTER	88
	APPENDIX C JRMC APPROVAL LETTER.....	90
	BIBLIOGRAPHY	92

LIST OF TABLES

Table 1. Study Variables, Tools, and Collection Schedule.....	45
Table 2. Socio-demographic characteristics for the total sample (N=48) and for subjects with coronary artery disease only	72
Table 3. Pre-rehabilitation program clinical characteristics for the total sample (N=48) and for subjects with coronary artery disease only (CAD, n=26) and for subjects with type II diabetes plus coronary artery disease (T2DM+CAD, n=22).	73
Table 4. Pre-rehabilitation program patient profile factors for the total sample and for subjects with coronary artery disease only (CAD, n=26) and for subjects with type II diabetes plus coronary artery disease (T2DM+CAD, n=22).	74
Table 5. Post-Rehabilitation program clinical characteristics for the total sample (n=48) and in subjects with coronary artery disease only (CAD, n=26) and with type II diabetes plus coronary artery disease (T2DM+CAD, n=22).	75
Table 6. Group-specific descriptive and comparative statistics at pre and post rehabilitation program and the percentage of change over time for subjects with coronary artery disease only (CAD, n=26) and with type II diabetes plus coronary artery disease.	76

LIST OF FIGURES

Figure 1. Christensen's Patient-by-Treatment Context Interaction in Chronic Disease Model. ..	35
Figure 2. Christensen's Model Adapted to the Proposed Study Specific Aims.	37

PREFACE

Several individuals have assisted me in my educational pursuits and I am very grateful to everyone. I hold a deep respect for all my committee members who worked diligently that I met the highest academic standards. I will always emulate them as not only as educational role models but, experienced researchers.

I wish also to thank the staff, therapists, physicians and patients of the Cardiopulmonary Rehabilitation Unit at Jefferson Regional Medical Center and the Park Cardiothoracic and Vascular Institute for their cooperation and support of my research study. At the Jefferson Regional Medical Center, my original research questions were developed, and without whose support, this study would not have been instituted.

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1.0 INTRODUCTION

The Healthy People 2010 Physical Activity Health Indicator currently reveals that 11% or 23.5 million working age adults 20 years and older have been diagnosed with both coronary artery disease (CAD) and type 2 diabetes mellitus (T2DM), with estimates that an additional 9% of the total United States population will be diagnosed with this dual disease combination by the year 2025 (Boyle, 2001; National Center for Chronic Disease Prevention and Health, 2008). Projected health care costs for this working age population, including direct medical care costs and indirect costs (physical and psychological disabilities, work loss, premature mortality), will exceed \$620 billion U.S. (Boyle, 2001). Moreover, the risk of developing a myocardial infarction (MI) is 2-4 times greater in these individuals as compared to individuals diagnosed only with CAD (ADA, 2003; Mayfield, 1999). Several studies have confirmed that 25% to 32% of all patients with MI requiring a revascularization procedure have both CAD and T2DM (Flaherty, 2005; Hindman, 2005).

When patients undergo a revascularization procedure such as a coronary artery bypass graft (CABG), the primary intervention prescribed for these patients to regain functional ability afterwards is enrollment in a standard outpatient cardiac rehabilitation program (CR). These programs, ranging in duration from 6 to 12 weeks, have been shown to improve the physical function of CAD patients by up to 15%, but patients diagnosed with the chronic disease states of T2DM+CAD exhibit only an 8% improvement (Egede, 2004; Hindman, 2005; Verges, 2004).

Likewise, many research investigations have corroborated that T2DM+CAD patients experience much lower rates of cardiac rehabilitation program appointment adherence and greater attrition (45-62% T2DM+CAD vs. 92% CAD) (Egede, 2004; Hindman, 2005; Mayfield, 1999; Verges, 2004).

The specific causes for lower cardiac rehabilitation program appointment adherence and poorer rehabilitation program outcomes for T2DM+CAD patients are still unknown. The “Patient-by-Treatment Context Interaction in Chronic Disease Model” developed by Dr. Alan Christensen provides direction for understanding how the multiplicity of individual disease perceptions and intrapersonal factors interact to impact treatment adherence (Christensen, 2000). The primary assumption of this behavioral-based model is that by analyzing specific patient profiles (sociodemographics, personality traits, locus of control, coping strategies, social support, and treatment efficacy) in relationship to relevant patients illness contextual factors (specific disease stage, illness severity levels, treatment regimen complexity and co-morbidities), individualized interventions can be designed to improve treatment adherence rates, and therefore treatment outcomes (Christensen, 1997; Christensen, 2000).

Therefore, the primary purpose of this prospective, descriptive pilot study was to use Christiansen’s “Patient-By-Treatment Context Interaction in Chronic Disease Model” to explore if differences exist between the patients profiles and illness contextual factors of patients with CAD only and T2DM+CAD at entry to a standard outpatient cardiac rehabilitation program after CABG, as well as potential differences in program adherence and outcomes at program conclusion. Understanding these potential differences will provide pilot data to establish reasons why T2DM+CAD patients have poorer program adherence and outcomes, and if cardiac rehabilitation interventions adjusted to their specific profiles and factors would be beneficial.

1.1 SPECIFIC AIMS

The specific aims of this pilot study were to:

(1) Explore differences in patient profiles (sociodemographics, personality traits, locus of control, coping strategies, social support, and exercise treatment efficacy) between T2DM+CAD and CAD patients at entry to a standard outpatient cardiac rehabilitation program.

(2) Explore differences in illness contextual factors (specific disease stage, illness severity levels, treatment regimen complexity, and co-morbidities) between T2DM+CAD and CAD patients at entry to a standard outpatient cardiac rehabilitation program.

(3) Explore differences in program adherence (appointment attendance and medication adherence) and outcomes (changes in functional status and illness severity markers) between T2DM+CAD and CAD patients upon conclusion of a standard outpatient cardiac rehabilitation program.

(4) Explore the main and interaction effects of both the patient profiles and illness contextual factors within the T2DM+CAD and CAD patients groups on program adherence (appointment attendance and medication adherence) and outcomes (appointment attendance and medication adherence) upon conclusion of a standard outpatient cardiac rehabilitation program.

1.2 REVIEW OF LITERATURE

Miketic JK, Hravnak M, Stilley CS, Robertson RJ, Sereika SM. (2011) Factors Influencing the Outcomes of Patients With Both Coronary Artery Disease and Diabetes Enrolled in Standard Cardiac Rehabilitation Programs: A Literature Review. *Journal of Cardiovascular Nursing* May/June; 26:210-217.

The copyright approval letter to use this manuscript in this dissertation may be found on page 79 of Appendix A.

1.2.1 Abstract

Currently 23.5 million working age adults 20 years and older have been diagnosed with both coronary artery disease and type 2 diabetes mellitus with estimates that an additional 9% of the total United States population will be diagnosed with this chronic disease combination by the year 2025. Current annual health care costs for this working age population including medical costs, functional disability, work loss, and premature mortality currently exceed \$620 billion. Prior research efforts have shown that 25% to 32% of patients requiring a coronary revascularization procedure have both coronary artery disease and type 2 diabetes mellitus. The primary intervention prescribed for these patients to regain functional ability after revascularization is enrollment in a standard outpatient cardiac rehabilitation program (CR). These standard programs, ranging in duration from 6 to 12 weeks, have been shown to improve the physical function of coronary artery disease (CAD) patients by up to 15%, but patients diagnosed with both chronic conditions of coronary artery disease and type 2 diabetes mellitus (T2DM+CAD) attending these same programs exhibit only an 8% improvement. Moreover, T2DM+CAD patients experience much lower rates of rehabilitation program appointment

adherence as well as greater program attrition (45-62% T2DM+CAD vs. 92% CAD). Current literature regarding the relationship between CAD, T2DM, and CR will be examined to identify specific factors that could influence the functional outcomes achieved by the T2DM+CAD population when enrolled in a standard CR program and help increase understanding of why the adherence and attrition differences exist.

1.2.2 Prevalence of Type 2 Diabetes Mellitus and Coronary Artery Disease

According to the American Diabetes Association's 2010 position statement, diabetes is a chronic condition that continues to influence both major public health and economic issues in the United States (ADA, 2010; Songer, 1998). Due to lifestyle preferences that promote physical inactivity and increasing rates of obesity, the number of Americans diagnosed with the most prevalent form of diabetes mellitus (Type 2 or Adult onset) is projected to increase from 21 million to 29 million in 2050 (ADA, 2003; Boyle, 2001; U.S. Department of Health and Human Services, 2008).

The underlying causes of type 2 diabetes mellitus (T2DM) result from a combination of impairment in insulin-mediated glucose disposal and insulin secretion by pancreatic beta cells (Grundy, 2002; Bergenstal, 2007). T2DM, if left untreated, has been shown to be a strong contributor in the development of CAD (Grundy, 2002; Bergenstal, 2007). The Healthy People 2010 Physical Activity Health Indicator currently reveals that 11% or 23.5 million working age adults 20 years and older have been diagnosed with both CAD and T2DM, with estimates that an additional 9% of the total United States population will be diagnosed with this dual disease combination by the year 2025 (Egede, 2002; National Center for Chronic Disease Prevention and

Health, 2008, National Center for Health Statistics, 2008). Projected health care costs for this working age population, including direct medical care costs and indirect costs (disability, work loss, premature mortality), currently exceeds \$620 billion U.S. (Bergental, 2007). The risk of developing a myocardial infarction (MI) is 2-4 times greater in these individuals as compared to individuals diagnosed only with CAD (Sahakyan, 2006). There is also evidence that although the overall CAD mortality rates have decreased in the total United States population, CAD mortality is not declining in the DM population (Gu, 1999). Several studies have confirmed that 25% to 32% of all patients with MI requiring a revascularization procedure have both CAD and T2DM (Sahakyan, 2006; Julien, 1997).

The primary intervention prescribed for these patients to regain functional ability after revascularization is enrollment in a standard outpatient cardiac rehabilitation program. These programs, ranging in duration from 6 to 12 weeks, have been shown to improve the physical function of CAD patients by up to 15% but, patients diagnosed with both chronic disease states of T2DM+CAD exhibit only an 8% improvement (Egede,2004). Moreover, many research investigations have corroborated that T2DM+CAD patients experience much lower rates of rehabilitation program appointment adherence and greater attrition (45-62% T2DM+CAD vs. 92% CAD) (Egede,2004;Hindman,2005;Verges,2004). Therefore, the purpose of this T2DM+CAD literature review is to enhance the nurses' understanding of potential factors that may influence this unique population's functional outcomes prior to and after enrollment in a standard cardiac rehabilitation program.

1.2.3 Review of Literature Method

Original articles published in the English language were identified through an OVID and Medline literature search conducted for the years of 1996 to 2010. The following key terms were utilized alone or in combination for the specific literature search: diabetes mellitus, type 2 diabetes mellitus, cardiovascular disease, coronary artery disease, cardiac rehabilitation, functional outcomes, disability, physical activity, adherence, revascularization and coronary artery bypass graft.

All the articles examined were studies based on exploring some aspect of the relationship between coronary heart disease, type 2 diabetes mellitus and cardiac rehabilitation. Since only English translated research articles were examined, this literature review may have missed some documentation discussing significant findings between the combined CAD, T2DM+CAD and CR evidenced from foreign medical research investigations. In addition, recent position papers on diabetes and cardiovascular disease were reviewed to provide a comprehension review of the current medical standards of care for both the CAD and T2DM patient population. From this literature search, four major areas appeared to emerge concerning the relationship between coronary heart disease, type 2 diabetes mellitus and cardiac rehabilitation. The first area was the relationship investigated between the concept of overall functional disabilities and the chronic disease state of T2DM. The second area was research involving the examination of the association of exercise and T2DM. The third area included exploration in the pathophysiological patterns present in patients with T2DM+CAD. The final area, which yielded the smallest percentage of research articles, was an inquiry into documented outcomes of T2DM+CAD in cardiac rehabilitation programs.

1.2.4 Functional Disability and Type 2 Diabetes Mellitus

Functional disability defined as difficulty performing daily living, routine social or work related activities is highly prevalent in individuals diagnosed with chronic diseases such as diabetes mellitus (Gregg, 2000). Several studies conducted between 1999 and 2005 investigated this specific functional relationship between T2DM and disability.

Gregg found in his analysis of the Third National Health and Nutrition Examination Survey (NHANES III) data that 1.2 million U.S. adults (one-fourth of population from the NHANES sample) were diagnosed with T2DM and unable to do simple mobility tasks defined as walking one-fourth of a mile (Gregg, 2000). Moreover, the NHANES T2DM population demonstrated slower walking speeds, chair-stand performances and balance positioning abilities (Gregg, 2000). Gregg associated the decline in these higher physical activities to be due to both diabetic complications (retinopathy and neuropathy) and associated coronary heart disease co-morbidities such as microvascular disease (Gregg, 2000).

Gregg later went on to utilize data from a study of Osteoporotic Fractures, in which he analyzed both intrinsic (obesity, hyperglycemia) and extrinsic (coronary heart disease, peripheral vascular disease) factors to determine the extent of functional disability in older women with T2DM (Gregg, 2002). This specific research investigation demonstrated that the development of functional disabilities in performing routine bathing, dressing or low impact mobility tasks was doubled (10%) for women with T2DM as compared to women without T2DM (5%) caused by socio-demographic classification and access to healthcare (Gregg, 2002).

Blaum's research classified older adults into high, intermediate and low functioning individuals diagnosed with and without T2DM and followed their performance activity levels for two years (Blaum, 2003). Data were obtained from the Study of Assets and Health Dynamics

among the Oldest Old (AHEAD), a longitudinal study of a nationally representative cohort of persons aged 70 and older living in a community setting (Blaum, 2003). High functioning individuals were defined as reporting no limitations in tasks involving *Physical Functioning Tasks* (walking several blocks, climbing one flight of stairs, lifting 10 pounds) *Instrumental Activities of Daily Living Tasks* (taking medications, using the telephone, managing money) and *Personal Care Tasks* (dressing, bathing, toileting, eating) (Blaum, 2003). Thirty-nine percent of this population had T2DM. Intermediate functioning adults demonstrated difficulties in two of the three functional categories with T2DM's comprising 36% of the total intermediate population (Blaum, 2003). Low functioning adults reported limitations in all three functioning categories and as expected in the sample size calculation, 24% of adults were diagnosed with T2DM (Blaum, 2003). This two-year investigation revealed that 25% of T2DM adults continued to enjoy high functioning status but showed a significantly higher rate for the development of cardiovascular disease than people without DM (Blaum, 2003). The characteristics of this high functioning T2DM group revealed that they were younger, had a higher educational level and had better access to chronic disease care allowing them to practice preventative disease behaviors as prescribed by their health care team (Blaum, 2003). Those T2DM subjects who were initially defined as low functioning exhibited minor changes in their functional status for the two year study participation time whereas, intermediate functioning adults displayed the greatest change in routinely performing all required physical functioning, instrumental activities of daily living, and personal care tasks (Blaum, 2003).

Two notable conclusions can be drawn from this study. First, the non-decline in functional status for high functioning diabetics may be related to the good preventative healthcare practices of this group. Secondly, the decline in the intermediate functioning

population may be correlated with the progressive development of complications associated with microvascular degeneration and associated co-morbidities such as CAD (Blaum, 2003). Research by Egede focused on the connection between functional disability, T2DM and depression. Data used in this study came from the National Health Interview Survey (NHIS) (Egede, 2004). Several important conclusions resulted from this study. Individuals with T2DM developed major depressive episodes at more than two times greater the rate (58.1%) than individuals without DM (24.5%) (Egede, 2004). T2DM subjects with other co-morbidities such as CAD or congestive heart failure developed major depressive episodes at three times the rate (77.8%) compared to non-diabetic individuals (Egede, 2004). A study that confirms Egede's findings that depressive illness is strongly associated with disease complications and work disability was conducted by Von Koref (Von Koref, 2005). Twenty-four percent of his enrolled T2DM subjects reported that they had experienced either a minor or major depressive episode with 19% indicating that the depressive incident resulted in significant work disabilities (defined as missing greater than 5 days of work per month) (Von Koref, 2005).

Continuing with the investigational theme of functional disability, Mayfield's research used data obtained from the National Medical Expenditures Survey-2 (NMES), and investigated the sole concept of "Work Disability" in T2DM (Mayfield, 1999). This form of disability was defined as a complex interaction of health conditions, functional status, special work requirements and available economic alternatives (Mayfield, 1999). Thirty percent of the women with T2DM were classified as work disabled (Mayfield, 1999). In addition, work disability or functional impairment rates between male and female diabetics were found to differ by only 5% (Mayfield, 1999). However, Sanderson's research reported that the main deterrent preventing

women from attending a CR program was low income and education, not disability (Sanderson, 2010).

Therefore, these studies on the functional disabilities of patients with T2DM clearly indicate some of the profound and detrimental influences (preventative health practices, socio-demographic status, gender and education) that eventually lead to the chronic disease complications and comorbid disease progressions that cause T2DM individuals to be eventually classified as severely impaired.

1.2.5 Exercise and T2DM

The American Diabetes Association and the American College of Cardiology issued a combined statement about the benefits of T2DM individuals participating in routine exercise programs. Diabetics who regularly engage in physical activity improve their glycemic control by stimulating glucose utilization and improving insulin sensitivity and glucose uptake in muscles resulting in a decline in blood glucose (ADA, 2004). A single bout of aerobic exercise on insulin sensitivity may last as long as 24-72 hours and reduce HbA1C levels by 0.66% (ADA, 2004; ACC, 2004). Physically active diabetics also have been shown to exhibit lower blood pressures readings, increased HDL cholesterol levels, decreased triglyceride levels, plus decreased anxiety and depression episodes (Cauza, 2006; Chipkin, 2001; Eyre, 2004; Tekin, 2006). These factors are favorable to not only protect diabetics against the development of diabetic complications, but also cardiovascular disease as well.

The position on exercise activity for diabetics was developed by examining the results of current studies such as Loimaala's 2003 investigation on the effects of exercise training on

glycemic control, cardiovascular performance and systemic vascular resistance in T2DM population. This study showed that T2DM subjects who completed a 52-week endurance exercise program, improved their maximal oxygen consumption level by 2.3%, decreased their HbA1C values from 8.2 to 7.5%, and increased muscle strength and exercise capacities (measured by performing sit-ups and leg extensions exercises) by 7.7% (Loimaala, 2003).

Sigal's research contributed to the importance of exercise for the T2DM subject by focusing on investigating the physical effects of aerobic training alone, resistance training alone, and the combined aerobic/ resistance exercise on HbA1C levels (Sigal, 2007). The investigator stated that a 1% decrease in HbA1C values can be associated with a 15% to 20% decrease in developing a major cardiovascular event and a 37% reduction in microvascular complications (Sigal, 2007). This study concluded that participation in either aerobic or resistance training can positively change overall HbA1C values (8.1% Aerobic vs. 18.9% Resistance) (Sigal, 2007). However, the greatest change in these HbA1C levels (20.3%) occurred when subjects participated in a combined aerobic/ resistance training program (Sigal, 2007).

Gender and social demographics also exhibit a noteworthy effect on the physical activity behavior patterns of the T2DM population. Research performed in 2007 on data derived from the Alberta Longitudinal Exercise and Diabetes Research Advancement (ALEXANDRA) study revealed that T2DM men participated in more exercise activities than women (Barrett, 2007). Furthermore, these men were better educated and had substantially larger sources of income which allowed them to partake of more leisure time physical activities such as jogging, hiking, aerobics classes, strength training and sports (Barrett, 2007). In contrast, T2DM women were more likely to have low-incomes and categorize their primary physical activities as walking

while performing errands or performing routine household duties (Barrett, 2007). This study also concluded that the best activity to promote exercise in all gender and socio-demographic T2DM segments is walking (Barrett, 2007). In addition, the ALEXANDRA study researchers concluded that employers may consider providing fitness centers emphasizing health prevention and physical activity classes in the workplace so as to make exercise a more convenient activity for younger working class individuals with T2DM (Barrett, 2007).

In summary, these exercise based research efforts for T2DM individuals concurred in demonstrating that all forms of physical activity, including the simple act of walking, can both improve diabetic control as well as reduce both future diabetic and cardiovascular complications.

1.2.6 Pathophysiological Patterns with T2DM+CAD

The American Heart Association describes T2DM primarily as a cardiovascular based disease (Grundy, 2002; Rosano, 2006). Recent research efforts have identified that specific clustering of independent cardiovascular risk factors, like dyslipidemia and hypertension, combined with changes in prothrombotic factors, such as increased fibrinogen and plasminogen activator inhibitor-1 levels, increase the likelihood of the affected individuals being diagnosed with cardio metabolic or insulin resistance syndrome (Grundy, 2002; Rosano, 2006).

Moreover, the microvascular complications resulting from this syndrome not only can lead to diabetic complications such as peripheral neuropathy, but also are associated with increased rates of mortality and morbidity (Rosano, 2006).

Investigators have demonstrated that the poor prognosis witnessed in the T2DM+CAD population may be caused by a combination of enhanced myocardial dysfunction and accelerated

atherogenesis involving the distal coronary segments, resulting in congestive heart failure and cardiovascular collapse (George, 2001; Julien, 1997). Therefore, patients with major coronary artery occlusion are likely to also have more advanced microvascular disease. Interestingly, several research investigations have demonstrated that the extent of the atherosclerosis process present in a T2DM+CAD person can be positively or negatively enhanced by the individual's self-initiated behaviors of monitoring blood pressure levels, eliminating smoking habits and maintaining recommended waist-girth patterns (George, 2001; Grundy, 1999).

An interesting study performed by Bowden in 2006, increased understanding of the genetic relationship between cardiovascular disease and T2DM. After conducting careful analysis on 1079 genotypes from concordant siblings in the North Carolina, this Diabetes Heart Investigation determined that chromosome 3p was the probable source of a linkage existing between T2DM, Cardiometabolic syndrome and CAD (Bowden, 2006). Future research efforts on this chromosome to substantiate this genetic clue as the link between CAD and DM will be necessary to substantiate this important finding.

Two other studies were identified which examined the relationships between T2DM and cardiovascular symptom management. Rachmani's study examined if shared therapeutic responsibility between T2DM+CAD patients and their health care provider retarded the progression of both micro-and macrovascular complications (Rachmani, 2002). Results showed that patients who did not maintain a proactive association with their primary health provider had higher HbA1C values (8.9% proactive group vs. 8.2% standard group), higher LDL levels (124 mg/dl proactive group vs. 114 mg/dl standard group), and a higher incidence of developing cardiovascular related events (36 proactive provider group versus 23 standard relationship group) (Rachmani, 2002).

Saydah's work assessed the effectiveness of standard medical care for controlling risk factors for vascular disease in T2DM patients. Like Gregg, her primary data source came from the Third National Health and Nutrition Examination Survey (NHANES) (Saydah, 2004). She compared data on T2DM+ CAD subjects collected from both the NHANES and NHANES III investigations. In looking at these comparisons of standardized treatment recommendations for control of vascular complications, she chose to analyze HbA1C, blood pressure and total serum cholesterol levels. The overall mean value HbA1C levels did not change over time from the NHANES (7.7%) to NHANES III (7.6%)—a span of 12 years (Saydah, 2004). Additionally, the overall mean blood pressure values did not substantially change from the NHANES (138/74 mm Hg) to NHANES III (131/73 mmHg) (Saydah, 2004). However, 66.1% of NHANES subjects had cholesterol levels over 200 mg/dl as compared to 52% of subjects from the NHANES III study (Saydah, 2004). Thus, she concluded that medical treatment practice patterns changes for the prevention of vascular disease in T2DM patients had only been changed slightly over time, and that further health efforts are needed to control risk factors for cardiovascular disease among individuals diagnosed with T2DM (Saydah, 2004).

In addition to the NHANES study, Mehler investigated the adequacy of treatment of hyperlipidemia in patients with T2DM enrolled in the Appropriate Blood Pressure Control in Diabetes trial (Mehler, 2003). He found that Only 19% of the 133 patients with known coronary artery disease had an LDL cholesterol level less than 100 mg/dL at baseline, and only 16% achieved this level at the completion of the study ($p = 0.37$) suggesting that hyperlipidemia is being treated sub optimally in this combined chronic disease population (Mehler, 2003).

In summary , these research articles on the pathophysiological patterns in T2DM+CAD research have validated the synergistic link between these two chronic disease states, but further

efforts must be made to implement health treatment changes for these conditions by the health care community.

1.2.7 CR Program Outcomes in Patients with T2DM+CAD

Coronary Artery Bypass Grafting (CABG) or coronary revascularization has been the treatment of choice to correct the atherosclerosis complications present in the T2DM population as evidenced by several studies. However, limited research studies have been performed on how to achieve a successful rehabilitation recovery in this specialized patient population.

Pennell emphasized that a successful outcome after coronary artery bypass graft starts with pre-surgical treatment practices such as implementing a strict glycemic initiative. (Pennell, 2005) Using data collected on 103 Post-CABG patients in Eastern United State hospital, Pennell found that by utilizing a glycemic practice plan, the length of stay for the T2DM+CAD patients was reduced by 1.2 days, 6.7% of the T2DM+CAD patients developed post-operative infections and only 2 patients died (Pennell, 2005).

Along the same research outcome focus of glycemic control, Verges enrolled 59 T2DM patients in a 2-month cardiac rehabilitation program to determine if these diabetic patients could obtain an increase in exercise capacity (maximal oxygen consumption = $\dot{V}O_2$ max) as non-diabetics post revascularization procedure (Verges, 2004). He found no significant pre-cardiac program differences existed between the T2DM and Non-DM groups in terms of left ventricular function, type of coronary event, site of MI, use of cardiovascular drugs, prevalence of hypertension and smoking history (Verges, 2004). However, the body mass index (BMI) was slightly higher in the T2DM group as compared to the Non-DM (28.3 kg/mvs. 24.9 kg/m) (Verges, 2004). After completion of the rehabilitation program, Verges found that changes in

peak V02 max for the diabetic group was significantly and inversely correlated with their fasting blood glucose levels, i.e. the lower the blood glucose the higher the exercise capacity ($r = 0.40$, $p = 0.002$) (Verges, 2004). He therefore concluded that the response to cardiac rehabilitation by T2DM patients may be influenced by blood glucose levels (Verges, 2004).

Yu's research continued this focus on glycemic control outcomes of T2DM patients participating in cardiac rehabilitation exercise programs (Yu, 2000). In a cohort of 418 patients enrolled in CR, the mean age was 64 years, 32% were diagnosed with T2DM, 70% of enrolled subjects were male and 49% were diagnosed with hypertension (Yu, 2000). His results showed that the re-hospitalization rate for T2DM+CAD patients was significantly longer than for CAD only patients (2.3 days T2DM+CAD vs. 1.6 days CAD, $p=0.04$), hospitalization length of stay was doubled (25.5 days T2DM+CAD vs. 11.4days CAD, $p=0.02$), and a significant trend was noted toward increasing fasting blood sugar levels for the T2DM+CAD patient as their participation in the CR program progressed (7.9 mmol T2DM Pre-CR vs. 9.0 mmol T2DM Post=CR, $p=0.11$) (Yu, 2000). However, no change in glucose levels in the CAD only population was present. (5.4 mmol Non-DM Pre-CR vs. 5.4 mmol Non-DM Post=CR, $p=0.23$) (Yu, 2000). So, based on Yu's study results, it is recommended that strict glycemic monitoring of T2DM patients during CR be initiated (Yu, 2000).

Dylewicz's studies promoted short term endurance training consisting of bouts of cycling for his research on glycemic control in the post-CABG T2DM population. His premise was this exercise would modify the carbohydrate metabolism due to the increase in binding and degradation of the I-insulin erythrocyte receptors will decrease insulin resistance (Dylewicz, 2000). Results from this study found that his hypothesis was correct. Blood glucose levels dropped from 111.2 pre-CR exercises to 97.8 mg/dl post-CR exercises (Dylewicz, 2000).

Moreover, an increase in insulin binding was noted 0.535 pg to 0.668 pg (Dylewicz, 2000). He concluded that CR programs designed with short-term endurance exercise induced favorable changes in glycemic control in the T2DM population (Dylewicz, 2000).

Banzer's research on the characteristics of cardiac rehabilitation in patients with T2DM addressed the adherence to CR program issue (Banzer, 2004). In an investigation on 952 patients enrolled in a 10 week CR program, he found 26% of the population was diagnosed with T2DM and 53% of these subjects were taking insulin and/or an oral hypoglycemic agent (Banzer, 2004). T2DM+CAD patients had a significantly lower exercise capacity at entry than CAD only patients (5.7 METS T2DM+CAD vs. 7.0 METS CAD, $p<0.00001$) (Banzer, 2004). Body Mass Indices of the T2DM+CAD population were also higher than the CAD population (34.1 T2DM+CAD vs. 30.8 CAD, $p<0.0001$) (Banzer, 2004). Most astonishingly, Post CR program results indicate that T2DM+CAD patients had a 62% dropout rate and withdrew from the program more often due to an exacerbation of medical problems (Banzer, 2004).

Soja's demonstrated that by using an intense multifactorial intervention that focused upon individualized diabetic education sessions, improvements in both exercise capacities and reductions in both blood pressure and HbA1C levels resulted in improved post cardiac rehabilitation program outcomes for the T2DM+CAD population (Soja, 2007). In this Danish Study of Impaired Glucose Metabolism (DANSUK) study, 104 patients with T2DM+CAD were followed in a 1-year intense CR program that consisted of intense nutritional counseling, cooking, smoking cessation, psychological support, pharmacological, risk factor management and exercise classes (Soja, 2007). In addition, a 24-hour telephone help-line manned by a trained staff was provided as well as consultations with physicians and nurses trained in internal medicine and cardiology (Soja, 2007). After the completion of this program, HbA1C levels

decreased by 0.65% ($p<.05$) allowing at least 67% of the enrolled T2DM+CAD patients to reach the optimal glycemic goal set at 6.5% HbA1c (Soja, 2007). Thus, it was determined that an intense multipronged CR intervention program is the best method for treating T2DM+CAD patients (Soja, 2007).

Some of the most interesting research on T2DM+CAD patients participating in cardiac rehabilitation programs has been conducted by Milani and Lavie. These seasoned researchers recognized that T2DM+CAD patients may have long-standing complications such as peripheral neuropathy, retinopathy, autonomic neuropathy and peripheral vascular disease. Their research revealed, like the DANSUK study, that each of these complications needs to be addressed by an individualized cardiac rehabilitation plan (Lavie, 2005; Milani, 1996). For example, they found that T2DM+ DM patients with peripheral vascular disease may utilize cycle ergometry and arm ergometry exercises to replace the traditional treadmill walking (Milani, 1996). In addition, Milani and Lavie investigated the psychological behaviors exhibited by T2DM+CAD patients in cardiac rehabilitation programs. Diabetics demonstrated a higher incidence of depression (T2DM+CAD 26% vs. CAD 14%, $p<0.03$) (Milani, 1996). They concluded that screening for depression prior to any active participation in a cardiac rehabilitation program is an essential assessment for the T2DM patient (Milani, 1996). These findings were interesting because in a study conducted by Maniar on the typical CAD focused rehabilitation population, older patients with CAD that began a CR program showed higher co-morbidity burdens, but displayed decreased depression index scores (Maniar, 2009).

In a more recently published article, Marout reported that prior to beginning a CR program, T2DM patients with CAD showed a higher prevalence of cardiovascular disease risk factors such as hypertension and hypercholesterolemia, and overall poorer physical attributes as

demonstrated by their body composition measurements than patients with CAD-only patients (Marout, 2010). Moreover, rates of depression were higher in the T2DM+ DM group as compared to the CAD-only group (Marout, 2010). But, both patient groups demonstrated significant improvements at the end of their CR programs in overall exercise capacities and body composition measurements (Marout, 2010).

In the last study reviewed, Völler followed patients with T2DM +CAD and CAD to specifically track the physiological changes that these patients' exhibit from hospitalization through CR program completion (Völler, 2009). He specifically examined physiological characteristics of blood pressure, lipid and glucose levels, and their relationship to specific pharmacological and general treatment management standards (Völler, 2009). He found that although improvements were made in reducing hyperlipidemia, hypertension and hyperglycemia control was not as successful, nor were hypertension and hyperglycemia being treated according to guideline recommendations (Völler, 2009). He concluded that in order to have patients' achieve optimal CR program goals for both T2DM+CAD patients and CAD patients, a multi-interventional treatment plan consisting of regular physical activity, healthy diet, and guideline-oriented drug based therapy must be initiated by medical care providers and strictly followed by the CR team (Völler, 2009).

Thus, these research investigations have shown that T2DM patients may start a CR program with inadequate glycemic control and poorer physical attributes, but a comprehensive individualized education and exercise program conducted by an interdisciplinary team may alleviate or prevent further cardiovascular and glycemic complications.

1.2.8 Review Limitations and Conclusions

The main limitation in conducting this review is that few research studies have examined the specialized patient population with the dual diseases of CAD and T2DM in the CR setting. Other limitations are that some of the reported studies had small participant populations from distinct areas and their characteristics may not reflect the general characteristics of the overall CR population. Most importantly, many T2DM patients present to a CR program with additional medical conditions such as osteoporosis, nephropathy, retinopathy or neuropathy and the effects of these co-morbidities in comparison to the typical CAD patient who has not been fully investigated in the CR environment.

All of these research studies described in the four focus areas indicate that to accurately prepare the T2DM+CAD patient for participation in a cardiac rehabilitation program, a total understanding of the individual's physiological, socio-demographic, and psychological dynamic patterns must be studied in detail. Thus, the following strategies may be considered to improve outcomes for the T2DM+CAD patients:

(1.) Development of comprehensive pre-CR assessment tools specifying the T2DM+CAD patients' socio-demographic, medical, psychological (depression) and pre-exercise conditions.

(2.) Development of a Cardiac Rehabilitation Interdisciplinary program focusing on aggressive glycemic control measures, nutritional plans, and participant-specific short-term endurance exercises.

(3.) Development of medical-work partnerships at both the primary care and rehabilitation levels designed to promote overall cardiovascular health in the diabetic and pre-diabetic populations.

(4.) Continued research efforts designed to examine not only how specific diabetic co-morbid conditions affect overall TD2M+CAD patient's CR outcomes, but behavioral-based variables as well. The implementation of these strategies can be the starting point for both improved outcome and treatment adherence goals for this very special T2DM+CAD population.

1.3 CONCEPTUAL FRAMEWORK

Research has shown that non-adherence to recommended chronic disease treatment regimens can be associated with the development of both short and long term medical complications as well as increased mortality and morbidity rates (Bergental, 2007). Patients with T2DM+CAD who adhere to their treatment plans reduce their risk for future functional complications (Renders, 2001). Research has demonstrated also that adherence to particular treatment plans can be directly correlated with the patient's concept of self-care management. As described in several scientific investigations, T2DM+CAD patients who developed cooperative relationships with their health care provider and became active partners in their treatment plan, improved their adherence to care rates by 13 to 25% (Koenigsberg, 2004).

According to Dr. Alan Christensen from the University of Iowa, most adherence research studies on chronic disease illness populations have generally utilized conceptual frameworks based upon the Five-Factor Model of Personality or Health Belief Models (Christensen, 2000). Christensen and other adherence investigators believe these models are only effective in explaining a limited aspect of psychosocial compliance variables (Wiebe, 1997). They fail to consider the diversity that exists among chronic disease populations presenting with different medical histories, associated comorbidities, sociodemographic circumstances, and treatment

plans (Christensen, 1998). Christensen believed that this diversity or “heterogeneity of patients” is a combination of psychological, personality and environmental variables and is the essential component to analyzing adherence behavioral patterns (Christensen, 2000). Moreover, he further hypothesized that the interaction effects of patient profiles with illness contextual factors is the dominant influence on adherence expression. Thus, all adherence research efforts should be designed around a comprehensive biopsychological assessment approach (Wiebe, 1997). Moreover, this type of comprehensive approach could lead to the development of successful interventions and thereby improve overall patient adherence to treatment rates. Therefore, “Christensen specifically designed “The Patient-by-Treatment Context Interaction in Chronic Disease Model,” (Figure 1) to meet this biopsychological gap in adherence research. Christensen proved the reliability of his behavioral model in his work with end stage renal patients.

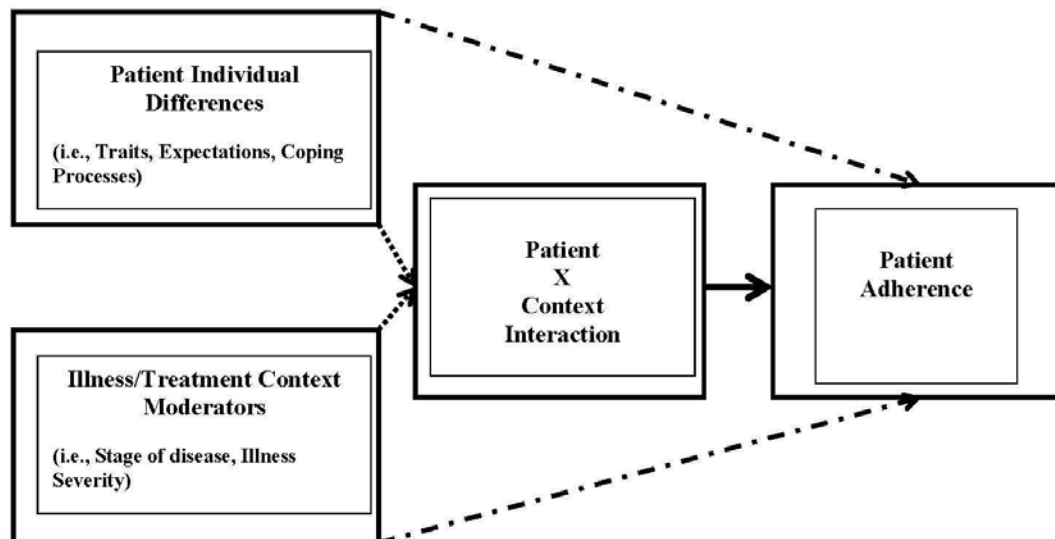


Figure 1. Christensen’s Patient-by-Treatment Context Interaction in Chronic Disease Model.

The central assumption tested in his model was that relevant illness contextual or situational features should be explicitly assessed, and the interaction of these factors with patient profile variables should be tested directly. By analyzing both the patient profile and illness contextual factors and their interactions in the end stage renal disease patient population, Christensen found that subjects who tended to be more internally focused, responded better to self-directed interventions than healthcare provider directed interventions. He further demonstrated that patients possessing a highly active and vigilant style of coping with their health care team demonstrated better adherence and adjustment when undergoing more self-directed renal treatment plans such as home dialysis or post renal transplantation care. Therefore, Christensen further conjectured that as an individual's chronic disease state progresses and the number of available treatment options increases, it becomes increasingly important for health care team members to understand the dynamic interactions that ultimately influence adherence patterns.

As stated earlier, Christensen's scientific studies were conducted primarily in the end-stage renal disease population, utilizing a combination of specific renal focused physiological, diagnostic, and qualitative measurement tools. This occurred because a key component to this model is that measurement devices should be defined in terms of the population being studied (Christensen, 2000).

Thus, "The Patient-by-Treatment Context Interaction in Chronic Disease Model," is the best framework to accomplish the specific aims of this pilot study, "Diabetic Coronary Heart Patients' Adherence to Cardiac Rehabilitation Programs." Figure 2 illustrates Christensen's model as adapted for this study. Adjusting Patient Profiles and Illness Contextual Factor measurements tools to be specific for both patient populations of T2DM+CAD and CAD increases the credibility value of all collected data because they have shown relevance with this

chronic disease population. In addition, the specific cardiovascular focused tools utilized will clearly aid in the explanation of the patient profile and illness contextual factor differences between the subject groups. Significant comprehensive compliance patterns that influence outcomes may also be evidenced by the usage of “The Patient-by-Treatment Context Interaction in Chronic Disease model.” Most research studies have focused on specific physiological outcomes as indicators of CR program success. The “Patient-by-Treatment Context Interaction in Chronic Disease Model,” is a comprehensive approach to evaluate this problem. Finally, the most important for the use of the conceptual model is significant interactions involving the T2DM+CAD and CAD groups may lead to the development of future adherence intervention strategies (and therefore improved outcomes) specifically for the T2DM+CAD population.

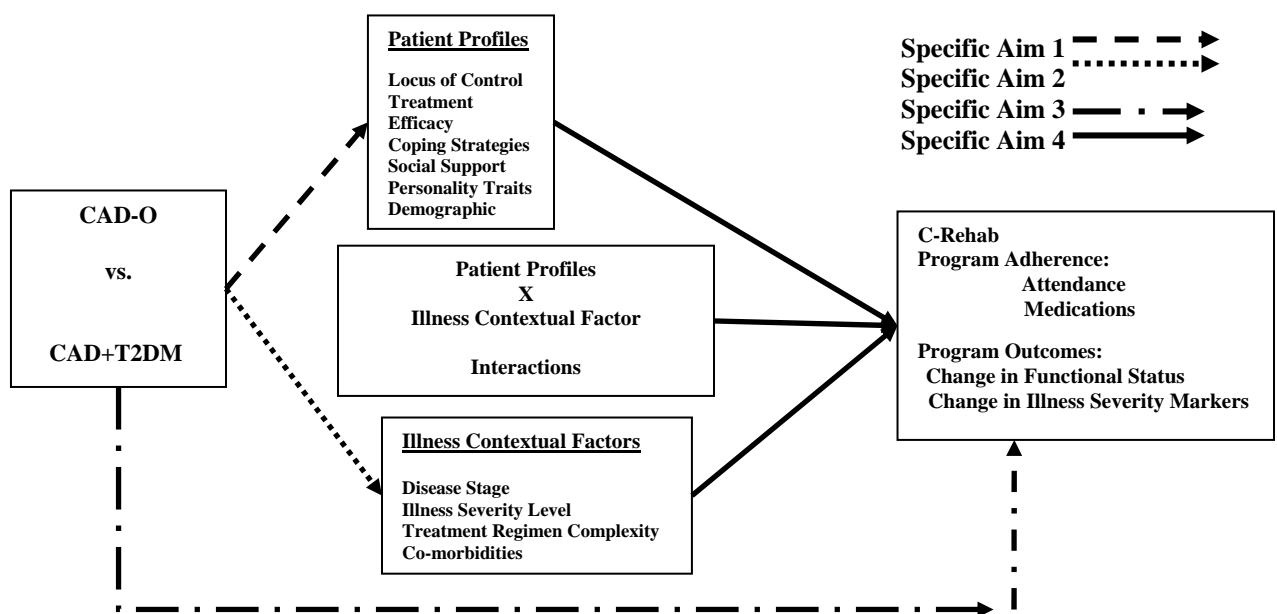


Figure 2. Christensen's Model Adapted to the Proposed Study Specific Aims.

1.4 SIGNIFICANCE OF RESEARCH STUDY FOR NURSING

To date, no nursing research study has specifically examined the reasons why cardiac rehabilitation program appointment adherence is poorer for T2DM+CAD patients or why T2DM+CAD patients who complete cardiac rehabilitation programs have poorer adherence and functional outcomes utilizing Christensen's "Patient-by-Treatment Context in Interaction in Chronic Disease Model". Understanding the multifactorial key components of the Christiansen model and how these components interact permitted this candidate to develop as an independent researcher. Moreover, by utilizing this novel theoretical approach, the data collected and findings revealed some clinically meaningful trends that are worthy of future investigation to inform CR care.

1.5 PRELIMINARY WORK

In preliminary preparation for this study, this candidate extensively reviewed both the coronary artery bypass graft procedure and cardiac rehabilitation enrollment statistics from Jefferson Regional Medical Center (JRMC) in order to ascertain the appropriate sample population size and demographic characteristics necessary to pursue this area of research. This work on the 2009 JRMC CR program statistics indicated that an average of 18 patients post primary isolated coronary artery bypass surgery were enrolled in their CR program each month. Importantly, sixty-five percent of all enrolled patients had a T2DM diagnosis. Estimating that 55% of eligible patient would be recruited with an attrition rate of 10%, recruitment of 44 subjects for this pilot study was determined as achievable within 7 months.

Furthermore, the abstract for research project, “Diabetic Coronary Heart Patients' Adherence to Cardiac Rehabilitation Programs” was accepted as a poster presentation for the Eastern Nursing Research Society’s 21st annual scientific meeting. The review of literature article, “Factors Influencing the Outcomes of Patients with Both Coronary Artery Disease and Diabetes Enrolled in Standard Cardiac Rehabilitation Programs” was published in the Journal of Cardiovascular Nursing.

To gain additional preparation to function as an independent investigator, the candidate served as a graduate student researcher on the National Heart, Lung, and Blood Institute’s Grant R01HL074316, “Myocardial Ischemia and Vasospasm in Aneurysmal SAH”. In this capacity, the candidate participated in subject recruitment, database management, data collection, data screening, statistical analysis and interpretation functions. These activities resulted in the submission of the manuscript entitled, “Relationship between Elevated Cardiac Troponin I and Functional Recovery and Disability in Patients after Aneurysmal Subarachnoid Hemorrhage” being accepted for publication by the American Journal of Critical Care. In addition, the abstract for this specific research activity was accepted as a poster presentation at the 2009 National Teaching Institute and Critical Care Exposition.

2.0 RESEARCH DESIGN AND METHODS

2.1 STUDY DESIGN

This pilot study utilized a prospective descriptive comparative design to deign to explore if differences exist in the patient profiles and illness contextual factors between T2DM+CAD and CAD patients upon standard CR program entry after CABG, and if differences exist between groups in CR adherence and outcomes at CR program conclusion.

2.1.1 The Patient-by-Treatment Context Interaction in Disease Model

The causes for lower CR adherence and poorer outcomes for T2DM +CAD patients have not been fully explored. The “Patient-by-Treatment Context Interaction in Chronic Disease Model” developed by Dr. Alan Christensen provides direction for understanding how the multiplicity of individual disease perceptions and intrapersonal factors interact to impact treatment adherence and in turn treatment outcomes. As stated in Section 1.3, the primary assumption of Christensen’s behavioral-based model is that by analyzing specific patient profiles factors (sociodemographics, personality traits, locus of control, coping strategies, social support, and exercise treatment efficacy) in relationship to relevant illness contextual factors (disease stage, illness severity level, treatment regimen complexity, and co-morbidities) individualized interventions can be designed to improve

treatment adherence rates, and therefore treatment outcomes. This pilot study design was based upon Christensen's model with some adaptation to accommodate the pilot study population as Christensen recommends (Christensen, 2000).

2.2 STUDY POPULATION

2.2.1 Setting and Recruitment

A convenience sample of subjects who enrolled in the standard Jefferson Regional Medical Center's (JRMCC) Phase 2 CR program following their CABG surgery between 12/16/2009 and 07/26/2010 were recruited. JRMCC is a 376-bed hospital located in the South Hills of Pittsburgh. Their CR program is supervised by a cardiologist, and consists of cardiac-monitored exercise sessions with exercise physiologists, nutritional counseling with a dietician, behavioral assessments with a psychologist, and risk factor modification classes administered by nurses. Subjects were recruited through referrals from JRMCC's Heart Institute physicians, nurses and therapy staff members. No "cold calling" occurred. Patients who met inclusion criteria (Section 2.2.2) were asked by the Heart Institute staff for their permission to be contacted by the study's Principal Investigator (PI). Specifically, JRMCC staff members discussed the research project with potential eligible patients and inquired if he/she expressed an interest in study participation. The patient signed a study approval form that (1) communicated with the PI that he/she was interested in study participation, (2) communicated with the PI the health information related to eligibility for inclusion into the study, and (3) allowed the PI to contact the patient for additional discussions related to the study. The PI asked the patient to sign a HIPAA-compliant consent

document for the study before a patient interview or medical record review of the patients chart for inclusion/exclusion criteria was conducted. The PI reviewed the study and all study procedures, risks and benefits with the patient prior to requesting signature for written informed consent to act as a subject in a research study. Questions were encouraged and assurances given that if they did wish to participate in the study, their medical and nursing care would not be affected. The patient's was informed that confidentiality of all information obtained would be maintained.

All subjects were followed from CR program entry to conclusion (8 weeks), and managed according to local practice guidelines based on national standards and guidelines set by the American Academy of Sports Medicine. The study was approved by both by the Institutional Review Board at the University and the Quality Improvement Research Committee at JRMC.

2.2.2 Subject Inclusion and Exclusion Criteria

Subjects of both genders were included if they had undergone a primary (first time) isolated (no other concomitant surgery) CABG procedure. Because patients undergoing repeat revascularization by definition have more functional impairment, the sample was limited to those undergoing their first or primary CABG to limit confounding. Because valvular heart disease imposes functional impairment different from CAD, only patients undergoing CABG alone, known as isolated CABG, were enrolled. Therefore, the sample consisted of patients who had undergoing primary isolated CABG to limit the chance that between group differences, if found, were related to factors other than T2DM+CAD vs. CAD. In addition, subjects were age >40 years, and had just been enrolled in the CR program. Exclusion criteria were age <40 years, had

undergone post-revised CABG or CABG combination surgery (i.e. CABG+Valve) or were not medically cleared for participation in the CR program.

2.3 STUDY INSTRUMENTS

A key component to the successful application of the “Patient-by-Treatment Context Interaction in Chronic Disease Model” is that all measurement devices should be defined in terms of the population being studied (Christensen, 1997; Christensen, 2000). Study instruments were therefore selected for their applicability to the CAD population. These study instruments, along with the collection schedule and their reported Cronbach's alpha as an indicator of instrument internal consistency are listed in Table 1.

2.3.1 Data Collection Times

The Principle Investigator (PI) was the sole data collector. The two time points for data collection were at CR program entry (baseline), and at the 8 week (conclusion) CR evaluation. Baseline data were collected within 1-7 days following the patient's first CR evaluation session, and the CR conclusion data were collected within 7 days of the last appointment in the 8-week session.

The PI was the sole data collector for this proposed pilot study.

2.3.2 Data Collection Management

Data collection was held in a private room at Jefferson Regional Medical Center's Cardiac Rehabilitation center at their first and last scheduled appointments. At both study points, the PI administered all study questionnaires, and performed all point-of-care testing. The time for the baseline assessment was 1 hour and the final assessment was 30 minutes. After initial information was obtained, the PI determined if the subject's status with respect to group membership was allocated to the T2DM+CAD or CAD group.

De-identified code numbers were assigned to each subject to maintain confidentiality. A listing of these de-identified code numbers to patient names were kept in an encrypted external pass protected word file. All data was hand entered in a specially designed database. Hard copy data forms and security USB drive holding the Data Transfer Files were kept by the PI in locked file cabinets in a locked office. All data collection forms will be filed in a double locked cabinet/office area in the University of Pittsburgh School of Nursing for a period of 5 years.

Table 1. Study Variables, Tools, and Collection Schedule.

Variables and Tools	Collection Schedule		Reported Cronbach's alpha
	Program Entry	Program Exit	
T2DM Disease Stage: 1. Diabetes HbA1c	X	X	
Patient Profile Factors: 1. Standard Demographic Tool 2. Personality Traits (Neo Five Factor Inventory) 3. Locus of Control (Multi Locus of Control) 4. Coping Strategies (Brief Cope) 5. Social Support (Internal Support Evaluation List) 6. Perceived Treatment Efficacy (PTE)	X X X X X X		.89 - .95 .70 - .93 .50 - .90 .77 - .86 .95
Illness Contextual Factors: <u>CAD Disease Stage:</u> 1. Ejection Fraction 2. Number of CABG vessels <u>Illness Severity Level:</u> 1. NYHFC 2. CCASG 3. Blood Pressure 4. Body Composition <u>Treatment Regimen Complexity:</u> 1. Medication-Taking Pattern 2. Medication-Taking Questionnaire <u>Co-morbidities:</u> 1. Co-morbidity Form	X X X X X X X X X X X	X X	.61-.75 .61-.75
Program Adherence: 1. C-Rehab Appointment Attendance Record 2. Morisky Medication-Taking Questionnaire Program Outcomes: 1. % Change Functional Status (Jette Functional Status Index) 2. % Change in Illness Severity Markers	X X X X	X X X X	.61-.75 .65-.81

2.3.3 Group Designation

All patients were defined as having CAD by virtue of undergoing a CABG procedure, a criteria for admission to the rehabilitation program. The two study cohorts were further defined as follows:

The T2DM+CAD Group: CAD patients were defined as having T2DM if they had a history of DM, were being currently treated with insulin or an oral glycemic agent, or had a HbA1c $\geq 6.4\%$ without treatment with insulin or an oral glycemic agent. HbA1C was determined by a fingerstick blood sample obtained by the PI at rehabilitation program onset and analyzed by a point-of-care portable device (Metrika™; Sunnyvale, CA).

The CAD Group: CAD patients reported no clinical history of DM, no treatment with insulin or an oral glycemic agent, and a HbA1c $< 6.4\%$ without insulin or oral glycemic agents.

2.3.4 Patient Profiles

The components of patient profiles were measured by a variety of standardized questionnaires to assess sociodemographics, personality traits, locus of control, coping strategies, social support, and exercise treatment efficacy. Each of the patient profile tools yielded multi-item total and subscale scores. The questionnaires were all administered by the PI.

2.3.4.1 Sociodemographic Questionnaire

A standard 24-item Sociodemographic questionnaire designed by the University of Pittsburgh's School of Nursing was administered to all subjects. This questionnaire inquired about gender, age, race, primary language, income, home location, marital status, job classification, insurance type, religion, and education.

2.3.4.2 Personality Traits: NEO Five Factor Inventory

To understand the relationship between personality traits and health, the NEO Five Factor Inventory tool was utilized, which evaluates the five personality types of neuroticism, extraversion, openness, agreeableness, and conscientiousness (Costa, 1990). Higher scores on the NEO Five Factor Inventory indicate a greater degree of that characteristic in the subject (Costa, 1990). Cronbach's alpha for this tool range from .89 to .95 and the test-retest reliability has ranged from 0.63 to 0.81(Costa, 1990).

2.3.4.3 Locus of Control: Multidimensional Health Locus of Control

The locus of control was measured by the Multidimensional Health Locus of Control instrument (MHLC Form C). This questionnaire was designed to elicit beliefs about an individual's control over their health status (Wallston, 1994). Three areas of control are measured by this tool-- internal control, chance, and powerful others. The score on each subscale is the sum of the values

circled for each item on the subscale (i.e., where 1 = "strongly disagree" and 6 = "strongly agree") (Wallston, 1994). A higher score on the MHLC indicates the subject has a perceived higher degree of the corresponding area of control. According to the developer of this instrument, a person with an "internal locus of control" orientation believes that health outcomes are controlled by some action in which he himself engages, while a belief that health outcomes are controlled only by fate or luck is "chance", and finally that "powerful-others" is the belief that other people with power control important health outcomes Cronbach's alphas for this tool range from 0.70 to 0.93 (Wallston, 1994).

2.3.4.4 Coping Strategies: Brief Cope Scale

Coping Styles were measured by the Brief Cope Scale, a questionnaire designed to analyze individual problem solving and emotional coping behaviors in specific areas (Carver, 1990). It contains 28 items and is rated by the four-point scale, ranging from "I haven't been doing this at all" (score one) to "I have been doing this a lot" (score four); thus higher scores represent greater coping strategies used by the respondents. The specific coping strategy subscales are "self-distraction" or the act of pursuing other activities away from reality such as daydreaming. Taking proactive actions to remove or circumvent stressors is an example of an "active coping behavior". An attempt to reject the reality of the stressful event is the definition of "denial". Turning to the use of alcohol or other drugs is a way of disengaging from the stressor and is defined as "substance use". Getting sympathy determines "emotional support". Giving up, or the act of withdrawing efforts is defined as "behavioral disengagement". "Venting" is showing an increased need to discharge specific feelings. "Positive Reframing" is thinking about alternate ways to confront a particular stressor. "Planning" is organizing one's thoughts on how to

confront stressors. “Humor coping strategies” entail making jokes about a certain stressor. “Acceptance coping strategies” can be defined as accepting that a stressful event has occurred and is real. Finally, “religious coping strategies” involve the increased need to participate in religious activities to decrease the stressor. Cronbach’s alphas for this tool have been measured at a low of .50 to a high of .90 (Carver, 1990).

2.3.4.5 Social Support: Interpersonal Support Evaluation List

The Interpersonal Support Evaluation List (ISEL) was used to evaluate emotional, instrumental and informational social support received by each of the subjects (Cohen, 1993). The perceived ability of having someone with whom to talk over problems denotes the “Appraisal” subset of the ISEL. “Social tangibility” measures an individual’s perceived ability of asking for and accepting material aid such as help with money, transportation or housekeeping issues . “Self-esteem” measures an individual’s perceived worth. “Belonging” is the perceived ability of having someone to do things with, such as attending a CR program. Test-retest reliability (Pearson’s) for the ISEL tool has ranged from .77 to .86 and the internal alpha estimates range from .88 to .90 (Cohen, 1993).

2.3.4.6 Exercise Efficacy: Therapeutic Self-Efficacy for Exercise Scale

The Self-Efficacy for Exercise Scale, a 9-item questionnaire, was administered to evaluate exercise treatment perceptions and patient management (Wu, 2008). This scale measures a person's subjective estimation that he or she will be capable of engaging in a CR exercise

program three times a week. Higher values on the scale are indicative of subjects estimating they will be able to participate fully in exercise programs. (Wu, 2008).

2.3.5 Illness Contextual Factors

The components making up the Illness Contextual Factors were based on 1) CAD disease stage, 2) illness severity levels, 3) treatment regimen complexity, and 4) co-morbidities. Each of these components was measured by a variety of standard tools in combination with a comprehensive review of the subject's inpatient hospital medical and outpatient rehabilitation records.

2.3.5.1 Coronary Artery Disease Stage

Coronary artery disease stage was determined by reviewing the subject's medical record for his or her left ventricular ejection fraction (LVEF) percentage score (normal >50%, borderline 35-49%, abnormal <35%) (Curtis, 2003). Additionally, a comprehensive review of the subject's CR program record provided information on the number of vessel bypasses performed during their CABG procedure.

2.3.5.2 Illness Severity Levels

Illness Severity Levels was measured by first conducting a baseline New York Heart Association Functional Capacity Classification (NYHFC). This 4-item ordinal scale classified the extent of heart failure by placing patients in one of four categories; no symptoms, mild symptoms, marked limitation or severe limitations (Hurst, 2006). Moreover, the Canadian Cardiovascular Society Grading of Angina (CCSG) severity of illness scale was also completed. This scale 4-item scale (class 1, class 2, class 3, class 4) assessed illness severity according to the degree of physical limitations imposed by cardiac angina (Canadian Cardiovascular Society, 1976). Also, physical assessment information provided an indication of illness severity. Baseline blood pressure (BP) was assessed with a mercury sphygmomanometer and stethoscope with the patient in a sitting position after resting for 10 minutes. The Seventh Report of the Joint National Committee on Prevention, Detection, Evaluation, and Treatment of High Blood Pressure indicates that a BP of greater than 140/90 mmHg is indicative of Stage 1 hypertension (U.S. Department of Health and Human Services, 2009). Total body composition analysis consisted of measuring height, weight, and hip and waist circumference to determine body mass index (BMI) and waist-to-hip ratio (WHR). Height was measured with a standard height measuring tape. Subjects (in lightweight clothing and bare feet) were asked to step on a Tanita™ scale (Tokyo, Japan) to measure weight. BMI was then calculated by dividing weight in kilograms by height in meters, and BMI was then categorized as <24.9 not overweight, 25 to 29.9 overweight, and ≥ 30 as obese (Bays, 2007). Waist and hip circumferences were measured with a non-stretchable standard girth tape. For waist circumference (subject standing with arms at side, feet together, abdomen relaxed), the horizontal waist measurement was taken at the narrowest part of the torso between the umbilicus

and xiphoid process (American College of Sports Medicine, 2006). The horizontal hip circumference measure was taken at the maximal circumference of the hips/buttocks, just above the gluteal fold, and the Waist-to-Hip Ratio (WHR) then calculated by dividing the waist measurement by the hip measurement (American College of Sports Medicine, 2006). A WHR greater than 0.96 indicates that individuals are at greater risk for having serious cardiometabolic-related health problems such as dyslipidemia, hypertension, atherogenesis and obesity (American College of Sports Medicine, 2006).

2.3.5.3 Treatment Regimen Complexity

Treatment Regimen Complexity was determined by each subject answering the PI's questions on their medication taking pattern. The question asked determines reported medication adherence habits based on patterns of forgetfulness, carelessness, and attitudinal influences. In addition, the Morisky Medication Taking Questionnaire, a 4-item questionnaire was administered to measure their self-reported medication taking behaviors at CR baseline and conclusion. Scores on the Morisky closer to 1 indicated better levels of compliance with medication administration. The reliability of these tools is reflected in their 0.61 and 0.75 measures of internal consistency (Morisky, 1986).

2.3.5.4 Comorbidities

Comorbidities were obtained from responses on the Brief Co-Morbidity Questionnaire. This 90-item questionnaire designed by the Center for Research in Chronic Disorders of the University of

Pittsburgh's School of Nursing asked subjects about other acute or chronic disease processes with which that they have been diagnosed.

2.3.6 CR Program Adherence and Outcomes

2.3.6.1 CR Program Adherence

CR Program Adherence was evaluated by the number of prescribed CR visits that the patient actually attended divided by the prescribed number of sessions scheduled. Medication adherence was measured by comparing the initial answers of the subject's self-reported baseline Morisky Medication Taking Questionnaire results to their answers at CR program conclusion.

2.3.6.2 CR Program Outcomes

CR Program Outcomes were evaluated through changes in functional status and illness severity markers between the time of CR program entry and conclusion.

2.3.6.3 Functional Status Outcomes

For the outcome of functional status changes, the results of the Jette Functional Index Scale (JFIS) at CR baseline and conclusion were compared. Eighteen activities of daily living are self-reported by the patient, and then grouped into 5 categories: mobility, personnel care, hand activities, home chores, and role activities (Jette, 1980). Overall JFIS scores in functional areas

of the need for functional assistance, pain involved, and functional difficulty were then calculated by summing individual scores of all 18 items and dividing by the total number of items (Jette, 1980). Higher scores indicate more self-reported functional difficulty in accomplishing specific tasks or more assistance required to accomplish these tasks. Test-retest and internal observer values range from 0.65 to 0.81 (Jette, 1980).

2.3.6.4 Illness Severity Change Outcomes

For the outcome of illness severity changes, the comparisons of the baseline and CR program conclusion measurements of HbA1c, BP, BMI and WHR between the cohorts were compared, and the percentage of change within the cohort over time determined.

3.0 DATA MANAGEMENT AND STATISTICAL ANALYSES

3.1 DATA ANALYSIS FOR SPECIFIC AIMS 1, 2 & 3

Data were key-entered directly into the database by the PI and verified by an independent reviewer. PASW (Version 18.0, IBM, Inc., Chicago, IL, USA) was used for data analysis. Data screening performed prior to analyses included checking for accuracy input, outliers, amount and pattern of missing data, multicollinearity and violations in statistical assumptions (e.g., normality, homoscedasticity).

Group-specific statistics were computed considering each variable's level of measurement and data distribution for personality profile factors (Aim #1), illness contextual factors (Aim #2), and pre- to post-CR changes in program adherence and outcome variables (Aim #3). Normality assessment indicated that continuous type data were non-normally distributed. Thus, nonparametric methods were utilized to describe and compare study cohorts. Categorical descriptors were summarized using group-specific frequencies and percentages and contingency table analyses with chi-square tests of independence (or Fisher exact tests, if sparse cells) were employed to compare proportions between groups. Continuous type variables were described using group-specific medians and inter-quartile ranges and compared using the Mann-Whitney U-test between the study cohorts. Exact estimation of p-values was employed. Effect sizes (odds ratios [OR] for categorical factors and Cohen's D calculated as the standardized

mean differences based on ranked data) with 95% confidence intervals were computed to summarize the differences between study groups. The following social science guidelines for determining effect sizes were utilized; negligible effect $r \leq 0.049$, small effect size $r = 0.05 - 0.349$, medium effect size $r = 0.35 - 0.55$, large effect size $r = \geq 0.56$. (Cohen, 1988)

3.2 DATA ANALYSIS FOR SPECIFIC AIM 4

The statistical plan was to perform bivariate correlations and simple linear regression between Illness Contextual factors, Patient Profile factors, and program adherence and outcome variables if the univariate analysis demonstrated significance of relationships warranting further exploration. Next, multiple regression analyses was to be conducted to explore the main effects and two-way and three-way interaction effects of Illness Contextual factors, Patient Profile factors, and diabetes status on program adherence and outcome variables. In addition, effect sizes (regression coefficient with 95% confidence intervals) were to be estimated for each main effect and interaction effect. R-square statistics would be calculated to summarize the percentage of variance explained in the program adherence and outcome variables. Finally, residual analyses were to be performed to identify instances of model misspecification and influential observations.

4.0 HUMAN SUBJECT RESEARCH

4.1 RESPONSIBLE CONDUCT OF RESEARCH

The University of Pittsburgh Education & Certification Program in Research & Practice Fundamentals is an on-line educational series designed to provide training to individuals at the University of Pittsburgh, and its affiliated institutions, who wish to participate in research activities. This program is required of all doctoral students and students serving as Graduate Student Researchers (GSR's); the applicant functions in both roles. Several modules comprise the on-line training series and the modules required for doctoral students and GSR's include: Module 1-Research Integrity, Module 2-Human Subjects Research, Module 6-HIPPA Researchers Privacy Requirements, and Module 14-UPMC HIPPA Staff Security Awareness Training. Certificates of the candidate's successful completion of the modules are on file in the Student Affairs Office.

Moreover, ethical issues related to human subjects' research are incorporated in the BSN-PhD curriculum in both the Master's and Doctoral level courses including Nursing Theory and Research, Coordinating Clinical Trials, Research Methods, Qualitative Research, Pilot Study, Grant Writing Practicum and others. Areas covered in these courses include topics concerning the process of informed consent, participant confidentiality, conflict of interest, research integrity, protection of vulnerable subjects, internal audit procedures, seeking IRB

approval, adverse event monitoring as well as many more. Further instruction was also received through the various research seminars the applicant will attend including Survival Skills Workshop, Research Methodology Series and Research Progress Update Series available throughout the University. Additionally, having worked as a Graduate Student Researcher, the candidate has had first-hand experience of the detailed elements related to the responsible conduct of research- ensuring ID numbers are always separate from participant names, locking the secure computer database, maintaining privacy during the collection of bloodwork and cerebral spinal fluid. Working on a large study has proved to be an invaluable experience that introduced the applicant to the many of the aspects of conducting sound, ethical research.

4.2 INFORMED CONSENT AND THE IRB

Following a description of the research purpose and protocol including procedures, risks and benefits as presented by the PI, patients were asked to provide informed consent. Only patients providing informed consent were allowed to proceed to the data collection interview. Subjects were allowed to withdraw from the study at any time. Both the Institutional Review Boards at the University of Pittsburgh and Jefferson Regional Medical Center approved the study protocol prior to study initiation. The IRB approval form can be found in Appendix B and the JRMC approval letter is found in Appendix C.

4.3 PROTECTION OF HUMAN SUBJECTS

This study involved minimal risk. The PI performed all study procedures. There were no known risks with the measurement of height, weight, waist circumference, and BP. No patients being interviewed regarding personal demographics, medical history, or answering the questionnaires, reported having any discomfort regarding their social situation or recall of unpleasant experiences. In addition, the risks of blood sampling by fingerstick were minor, occurring in < 25% (< 25 out of 100 people) and this did not occur in the research study (Garon, 2004).

To minimize these risks, only the trained PI obtained fingerstick blood samples. There was some risk that a patient might become upset if a previously undiscovered condition of hyperlipidemia, hypercholesterolemia, or diabetes was discovered because of blood test results. This did not occur. There could be a risk to patient privacy if confidentiality of the research records was breached. All records were kept in a locked cabinet within the PI's locked office and this offense did not occur.

4.4 WOMEN, MINORITY AND CHILDREN INCLUSION IN RESEARCH

The study was based on the sample population demographics of JRMC. No potential participants will be excluded from the study based upon gender.

In terms of minorities, the proposed study was based on the demographics of JRMC and included 98% Caucasians and 2% African Americans admitted for primary isolated vessel CABG surgery. No potential participants will be excluded from the study based upon race or ethnicity.

Children were not included in this proposed research since: a) the prevalence of significant coronary artery disease requiring CABG in individuals < 21 years of age is almost non-existent, and b) the clinical site restricts admissions to adults.

4.5 DATA SAFETY AND MONITORING PLAN

Since this pilot study involved minimal interventional risk to subjects and is not a multi-site clinical trial, a formalized Data Safety and Monitoring Plan was not warranted for this study. However, with respect to participant safety and electronic data integrity, the PI reviewed monthly all data collection processes including point of care testing to assess that procedures were conducted according to standard research protocols. Furthermore, the PI issued a report to the Dissertation Chair regarding the findings of these monthly reviews.

5.0 RESEARCH RESULTS AND DISCUSSION: SPECIFIC AIMS 1-3

A convenience sample of 51 subjects was recruited. Two subjects requested to be withdrawn from the study and one subject chose to attend a different CR program center closer to his home after completing their initial CR program evaluation, leaving a final sample size of 48 (26 CAD and 22 T2DM+CAD subjects).

5.1 PATIENT PROFILE RESULTS

5.1.1 Patient Sociodemographic Results.

As displayed in Table 2, there were no statistically significant differences in sociodemographics between the CAD and T2DM+CAD cohorts, although the following trends were noted. The T2DM+CAD cohort has a smaller proportion of males (50%) than the CAD cohort (73%). The T2DM+CAD cohort tended to have a slightly higher proportion of subjects younger than 64 years (59%) than CAD (54%) subjects. Subjects in both cohorts were primarily white, English speaking, and married. More CAD subjects reported living in the city while more T2DM+CAD subjects reported living in a rural community setting. CAD subjects reported working or having worked in traditional management positions such as plant managers or productivity directors. Subjects with T2DM+CAD reported holding or having held labor positions such as steelworkers,

mechanics or secretaries. A higher proportion of the CAD cohort (62%) were still currently employed as compared to the T2DM+CAD cohort (46%). The majority of subjects in both cohorts reported gross income levels of more than \$50,000 per year, and the majority of both cohorts held commercial health insurance plans. Eighty-five percent of subjects in both cohorts indicated that religion played an important role in their healthcare decisions.

5.1.2 Pre Rehabilitation Program Clinical Characteristics Results

As expected, the T2DM+CAD cohort demonstrated significantly higher HbA1c values than the CAD cohort (Tables 3 and 6) since HbA1c was a cohort-defining variable ($p < 0.001$). Nevertheless, a little over 40% of the CAD cohort who did not have a prior T2DM history or intervention presented with a HbA1c level in the range of 5.7mg/dl to 6.4mg/dl, consistent with the definition of a prediabetic state. There were no statistically significant differences in the other clinical characteristics at baseline between the cohorts, but again trends were noted. About 54% of the T2DM+CAD cohort exhibited abnormally low LVEF compared to only abnormally low LVEF in only 8% of the CAD cohort. The CAD population tended to be more likely to have 5 or more vessels bypassed than T2DM+CAD subjects (39% vs. 23% respectively).

Only 19% of the CAD cohort and 9% of the T2DM+CAD cohort were of normal weight. Although not statistically significant, slightly more CAD subjects (54%) tended to have a BMI ≥ 30 as compared to T2DM subjects (46%), and the T2DM+CAD subjects tended to have a WHR in the high-risk range (36%) as compared to the CAD subjects (23%).

Even though at baseline the majority of both cohorts had systolic and diastolic BPs within the normal range, the systolic values for the T2DM+CAD group was slightly, although non-significantly, higher than the CAD group. The majority of both cohorts were placed in either

Class 1 or Class 2 of the NYHFC scale and the CCSG scale. There was a trend towards 12 or more co-morbidities being reported by the T2DM+CAD cohort (32%) than the CAD cohort (15%). Nevertheless, there were no significant between group differences in baseline self-reports for medication adherence, nor in functional abilities as measured by the Jette scale related to need for functional assistance, pain involved, or functional difficulty in performing tasks.

5.1.3 Patient Profiles Characteristics Results

Patient profile characteristic comparisons (Table 4) revealed no statistically significant differences between the cohorts. However, several of the between-cohort comparison effect sizes indicated a small to medium effect size, especially in the analyses of personality traits. The NEO Five Factor Inventory tool indicated that the CAD cohort tended to be more agreeable and conscientiousness, whereas the T2DM+CAD cohort tended to be more neurotic, extraverted and open. Although there were no statistically significant differences noted in locus of control between the cohorts, the CAD cohort tended to believe that chance controlled health outcomes, whereas the T2DM+CAD cohort tended to believe that internal control and powerful others was more important, as suggested by the small to medium effect sizes on these traits.

The Brief Cope assessment revealed that the T2DM+CAD cohort trended towards a greater likelihood to exhibit coping behaviors of active coping, emotional support, positive reframing (small effect size) and venting (medium effect size). The CAD cohort had a slightly higher tendency to use religious and acceptance coping styles (small effect size) more frequently than the T2DM cohort. However, none of the between-cohort comparisons were statistically significant.

On the Interpersonal Support Evaluation List, the cohorts were equal in the subscales of appraisal, tangible, and belonging categories while the CAD cohort trended towards higher self-esteem. Although there were no statistically significant differences between the cohorts on the Self-Efficacy for Exercise Scale, the CAD cohort thought of themselves as more likely to be able to participate fully in an exercise program than the T2DM+CAD cohort, as suggested by the medium effect size.

5.2 ILLNESS SEVERITY MARKERS

As noted in Tables 5 and 6, the T2DM+CAD cohort achieved small improvement in their HbA1c levels between baseline and conclusion of CR program. The CAD cohort actually increased their HbA1c levels over time. The HbA1c percent of change from baseline over time (4% improvement for T2DM+CAD and 5% worsening in CAD) was statistically significant ($p=0.045$). Otherwise, there were only minimal changes with small effect sizes in the other variables.

5.3 PROGRAM ADHERENCE AND OUTCOMES

5.3.1 Program Appointment and Medication Adherence

Both groups showed equality in program attendance, with about 80% of CR program appointments kept for both groups, and there were no significant between-cohort differences. No

differences in CR program adherence were noted. Both cohorts self-reported some medication non-adherence, with a tendency towards greater non-adherence for the T2DM+CAD cohort, and neither cohort improved from their baseline medication adherence by CR program conclusion.

5.3.2 Functional Status Results

No significant changes were demonstrated in the analyses of functional abilities between the cohorts, or within each cohort over time. However, several trends were noted. The CAD cohort demonstrated less need for functional assistance than the T2DM+CAD cohort at baseline. The T2DM+CAD cohort still needed more assistance at program conclusion, even though both cohorts improved slightly.

5.4 DISCUSSION

The results of this pilot study indicated that although few statistically significant differences between the cohorts were found, a number of trends that are clinically meaningful were revealed. Although our CAD and T2DM+CAD cohorts were statistically similar on sociodemographics, we did note some trends in gender and age. Our overall sample was about 2/3 male as has been typically reported in CR program literature (Mourot, 2010; Suresh, 2000), but our gender dispersion was 73% males in the CAD cohort and only 50% males in the T2DM+CAD cohort. This relatively greater tendency toward female gender in the cohort with diabetes might be related to the greater disease burden of T2DM in females. The literature indicates that although the prevalence of T2DM is only slightly higher in women as compared to men, the

cardiometabolic complications of diabetes has a significantly greater impact on women (Cowie, 1995; Wishner, 1996). Women diagnosed with T2DM also have as much as a 22-42% greater degree of functional disabilities due to diabetic complications like peripheral neuropathy or diabetic retinopathy. Although currently CR programs admit more men than women following revascularization (Deshotels, 1995; Sanderson, 2010; Mayo Clinic, 2010), the anticipated rise in T2DM+CAD prevalence in the future may in turn result in increased revascularization needs in women. If so, CR programs may need to be prepared to admit more women in the future. Such an eventuality might impact the approaches that CR programs take to exercise, diet and behavior modification (Gregg, 2000; Gregg 2002). Another interesting finding was that our T2DM+CAD subjects participating in CR tended to be of a slightly younger age than the CAD cohort. Although CAD alone is more prevalent in adults 65 years or older, T2DM risk increases at age 45 years, and heart disease death rates are about 2 to 4 times higher than in adults without DM (NIDDK, 2011). If our trend towards T2DM+CAD patients in CR programs being younger is supported by further study, then perhaps CR program approaches might require age-based readjustments.

We did not find any statistically significant differences between our cohorts on the other aspects of patient profiles, although again a few trends were noted. Our CAD cohort showed a tendency (medium effect size) towards higher conscientiousness. CAD patients have been linked in research to Type A behavior patterns (Suls, 1989), and are characterized by their competitive nature and desire to achieve (Suls, 1989). Although our T2DM+CAD patients tended to report lower self-efficacy for exercise (medium effect size), we also noted a tendency (medium effect size) for the T2DM+CAD cohort toward more adaptive coping strategies. Perhaps this tendency may be explained in part by having coped with a chronic disease state for a longer period of

time. Research has demonstrated that being able to manage a chronic disease with proactive self-care behaviors effectively reduces the overall risk of developing complications (Bai, 2009). CR programs might encourage exercise self-efficacy and tap into the coping tendencies of T2DM+CAD patients to provide insight to managing their disease state, since there is evidence that hosting intense multifactorial cardio-metabolic classes to highly capable T2DM patients generates improved physiological outcomes. (Bai, 2009)

In terms of Illness Contextual Factors at CR program entry, other studies have reported T2DM+CAD HbA1c levels in the range of 7.7 to 8.2 mg/dl (Suresh, 2001; Verges, 2004), while our T2DM+CAD cohort mean HbA1c at baseline was somewhat lower at 6.6 mg/dl. This may be partially due to a more recent emphasis on tighter glycemic control in DM patients than in the older comparative studies (ADA, 2010; Ford, 2008). However, a disturbing trend noted in our study is that 42% of the CAD cohort exhibited a HbA1c level in the range of pre-diabetes or 5.7-6.4 mg/dl. If corroborated in a larger study, CR programs will need to be vigilant in that many patients who are not diagnosed with DM may still be borderline for its development, and that diet and other cardio-metabolic risk factor modification should be emphasized.

Reinforcing the connection between cardio-metabolic risk factors and DM was the noted tendency that the T2DM+ CAD cohort had fewer vessels bypassed than the CAD cohort, while at the same time tending to have a lower baseline LVEF. These tendencies might be related to the increased likelihood of patients with DM to have a stronger microangiopathic component to their vascular disease process, rather than only large vessel lesions (Flaherty, 2005), as well as the propensity for DM patients to have a greater preponderance of diastolic dysfunction and myocardial fibrosis as the pathophysiologic underpinning to their heart failure (Brown, 2004; Paulsen, 2010). It might be helpful for CR programs to be aware that even though T2DM

patients have fewer vessels bypassed, they may still have remaining risk for myocardial perfusion abnormalities.

CR programs represent a multi-component process of medical evaluation and prescribed exercise plans combined with educational and counseling sessions aimed at targeting traditional risk factors for CAD, with the goal of changing behavioral patterns of participants in order to produce improved physiological results (Beswick, 2005, Woodgate, 2008). Prior research has suggested that T2DM+CAD patients are more likely to drop out of CR programs than CAD patients. Both of our cohorts demonstrated an 80% mean appointment adherence rate (or on average 5 missed sessions out of the 24 scheduled over the 8 weeks). Other research has noted CR appointment attendance rates of 92% for CAD patients and 42-62% for T2DM+CAD. Thus our CAD cohort had somewhat poorer attendance than reported by other studies, while our T2DM+CAD cohort was slightly better than others. Possibly, the lower rate of employment for our T2DM cohort as compared to CAD might have helped to foster their equivalence in appointment adherence. Our study interval was not long enough to determine if there was any seasonal variation in attendance which could have affected results.

When examining our findings obtained at CR program conclusion, we noted that self-reported medication adherence was less than perfect in both the CAD and T2DM+CAD cohorts, as evidenced by their Morisky scores of greater than zero, with slightly poorer adherence in the T2DM group, but both groups reported little improvement in medication adherence by CR program conclusion. This finding has implications for CR programs, since the literature suggests that practical support is associated with increased levels of adherence behaviors (Molloy, 2008), and such supportive measures might eventually improve a patient's medication taking pattern.

At program conclusion, we also noted that the illness severity measures including HbA1c levels, BMI, WHR or BP levels demonstrated no change from baseline in either cohort. In fact, the mean HbA1c level of our CAD cohort was higher at program conclusion than at baseline. These findings suggest that the duration of the standard 8-week CR program is too short a time for behavior to change, or for behavior changes to result in demonstrable improvement of illness markers or cardiometabolic risk factors. Due to insurance and financial constraints, most CR subjects participate in only the short 8-week CR programs. A recent investigation reported that to change patients' behaviors, it is recommended that CR programs include post-home care interventions to facilitate and reinforce CR learning (Arrigo, 2008). In terms of physical function, our preliminary study noted no significant functional improvements for either cohort in terms of need for functional assistance, pain involved, or functional difficulty in accomplishing tasks. However, our data indicated that although both groups demonstrated similar degrees of pain and difficulty in functioning, the T2DM+CAD cohort tended to need more assistance with function than the CAD cohort, at both baseline and program conclusion. Other studies have demonstrated that diabetics in CR programs are able to perform functions less well and have worse functional outcomes than individuals without diabetes. (Suresh, 2001; Verges, 2004). Our findings, although limited, corroborate this, and would lend some support to CR programs taking the special exercise limitations and needs of the diabetics into account, rather than applying a generic exercise program to all participants.

5.5 LIMITATIONS

Our study had several limitations. First, because this was a pilot study, our sample size was small and underpowered to demonstrate statistically significant results. Nevertheless, the measures of effect size are useful in determining which components should undergo further study and that some relationships may have achieved significance with a larger sample. Also, our study was limited to examining patients at only a single center, and the trends noted may not be generalizable. Third, our measures of medication adherence and physical function were obtained from self-reports, and more objective measurement approaches might have yielded different results. Also we did not collect data on exercise complexity or escalation, which might have provided additional information on functional outcomes.

5.6 CONCLUSION

This pilot study suggests that although the patient profiles and illness contextual factors of patients undergoing CR programs after CABG revascularization are statistically similar between CAD and T2DM+CAD patients, there are some interesting trends that may be clinically meaningful and worthy of further study. These trends, if proven to be significant in a better powered study, may help to determine if CR programs need to take the specialized personality and illness characteristics of patients with T2DM+CAD into account. Although not an aim of our study, we also found that CAD patients who were not diagnosed with DM frequently exhibited

HbA1c levels in the range of a prediabetic state, and CR staff should be vigilant to this potential problem. Lastly, few changes or improvements were noted in disease severity or physical findings over the CR program interval, but the 8-week time frame is likely too short for such to occur.

5.7 TABLES 2 TO 6

Table 2. Socio-demographic characteristics for the total sample (N=48) and for subjects with coronary artery disease only

Variables	All Subjects (N = 48)	CAD (n = 26)	T2DM + CAD (n = 22)	Test Statistic	p-value	Odds Ratio (95% Confidence Interval)
Gender n (%)				$X^2(1)= 2.70$	0.100	‡ 2.714 (0.814 - 9.047)
Male	30 (62.5%)	19 (73.1%)	11 (50%)			
Age n (%)				$X^2(1)=0.13$	0.715	‡ 1.238 (0.393-3.901)
≥64 years	21 (43.8%)	12 (46.2%)	9 (40.9%)			
<64 years	27 (56.2%)	14 (53.8%)	13 (59.1%)			
Race n (%)				$X^2(1)=0.015$	0.712	‡ 1.191 (0.070-20.212)
White	46 (95.8%)	25 (96.2%)	21 (95.5%)			
African-American	2 (4.2%)	1 (3.8%)	1 (4.5%)			
English Primary Language n (%)	48 (100%)	26 (100%)	22 (100%)			
Gross Income n (%)				FISHER EXACT N/A	0.625	‡ 1.083 (0.309-3.802)
≥\$50,000	25 (52.1%)	13 (50.0%)	12 (54.5%)			
<\$50,000	16 (33.3%)	8 (30.8%)	8 (36.4%)			
refused to disclose	7 (14.6%)	5 (19.2%)	2 (9.1%)			
Area n (%)				$X^2(1)=3.02$	0.082	‡ 0.357 (0.110-1.156)
Rural	24 (50.0%)	10 (38.5%)	14 (63.6%)			
City	24 (50.0%)	16 (61.5%)	8 (36.4%)			
Marital status n (%)				$X^2(1)=2.79$	0.094	‡ 3.143 (0.795-12.425)
Married	36 (75.0%)	22 (84.6%)	14(63.6%)			
Single	12 (25.0%)	4 (15.4%)	8 (36.4%)			
Job Class n (%) † n=46	n = 46	n = 26	n = 20	$X^2(1)=2.62$	0.106	‡ 2.513 (0.743-8.498)
Management	20 (43.5%)	14 (53.8%)	6 (30.0%)			
Labor	26 (56.5%)	12 (46.2%)	14 (70.0%)			
Are you currently employed? n(%)				$X^2(1)=1.24$	0.650	‡ 1.920 (0.606-6.079)
Yes	26 (54.2 %)	16 (61.5 %)	10 (45.5 %)			
No	22 (45.8 %)	10 (38.5 %)	12 (54.5 %)			
Insurance type n (%)				$X^2(1)=0.20$	0.654	‡ 0.765 (0.237-2.471)
Private	18 (37.5%)	9 (34.6%)	9 (40.9%)			
Commercial	30 (62.5%)	17 (65.4%)	13 (59.1%)			
Religion n (%)				$X^2(1)=0.23$	0.864	‡ 0.868 (0.172-4.379)
Yes important	41 (85.4%)	22 (84.6%)	19 (86.4%)			
High School n (%)				$X^2(1)=1.23$	0.546	‡ 2.500 (0.211-29.599)
Yes	45 (93.8%)	25 (96.3%)	20 (90.9%)			

† All Subjects N=46, CAD n=26, T2DM+CAD n=20 ‡= reference from first to second category of CAD-T2DM for calculating odds ratio.

Table 3. Pre-rehabilitation program clinical characteristics for the total sample (N=48) and for subjects with coronary artery disease only (CAD, n=26) and for subjects with type II diabetes plus coronary artery disease (T2DM+CAD, n=22).

Variables	All Subjects (N = 48)	CAD (n = 26)	T2DM + CAD (n = 22)	Test Statistic	p-value	Odds Ratio (95% Confidence Interval)
Hemoglobin A1C Range n (%) Normal ≤ 5.7 mg/dl ‡ Pre-diabetes 5.71-6.4 mg/dl Diabetes ≥ 6.5 mg/dl	16 (33.3 %) 17 (35.4 %) 15 (31.3 %)	15 (57.7%) 11 (42.3%) 0 (0.0%)	1 (4.5%) 6 (27.3%) 15 (68.2%)	$X^2(2)=28.59$	<0.001	‡0.122 (0.013-1.166) §Undefined (NA)
Hemoglobin A1C n (%) Normal < 6.4 mg/dl ‡ Diabetes ≥ 6.4 mg/dl	33(68.8%) 15(31.3%)	26(100%) 0(0%)	7(31.8%) 15(68.2%)	$X^2(1)=25.8$	<0.001	‡ Undefined (NA)
†Ejection Fraction Range n (%) Abnormal $\leq 35\%$ ‡ Borderline 36-49% Normal ≥ 50	5 (10.4%) 11 (22.9%) 31 (64.6%)	2 (8.0%) 4 (16%) 19 (76%)	12 (54.5%) 7 (31.8%) 3 (13.6%)	$X^2(2)=2.41$	0.299	‡0.292 (0.042-2.023) §0.026 (0.004-0.181)
†Ejection Fraction n (%) Abnormal <50% ‡ Normal ≥ 50	16(34%) 31(66%)	6(24%) 19(76%)	10(45.5%) 12(54.5%)	$X^2(1)=2.39$	0.139	‡ 0.471 (0.132-1.680)
Number of Vessels Bypassed <5 Vessels ‡ ≥ 5 Vessels	33(68.8%) 15(31.2%)	16(61.5%) 10(38.5%)	17(77.3%) 5(22.7%)	$X^2(1)=1.37$	0.241	‡ 2.125 (0.595-7.830)
Body Mass Index Range n (%) 0-24.9 Normal ‡ 25-29.9 Overweight ≥ 30 Obese	7 (14.3%) 17 (34.7%) 24 (50 %)	5 (19.2%) 7 (26.9 %) 14 (53.8 %)	2 (9.1%) 10 (45.5%) 10 (45.5%)	$X^2(2)=1.55$	0.487	‡3.571 (0.533-23.954) §1.785 (0.287-11.128)
Body Mass Index n (%) < 25 Normal ‡ ≥ 25 Abnormal	7(14.6%) 41(85.4%)	5(19.2%) 21(80.8%)	2(9.1%) 20(90.9%)	$X^2(1)=0.98$	0.321	‡ 2.381 (0.414-13.708)
Waist to Hip Radius Range n (%) Small risk <0.96 High risk ≥ 0.96	34(70.8%) 14(29.2%)	20(76.9%) 6(23.1%)	14(63.6%) 8(36.4%)	$X^2(1)=1.01$	0.313	‡ 1.905 (0.540-6.713)
New York Heart Association class n (%) Class 1 ‡ Class 2 Class 3 Class 4	23 (47.9%) 19 (39.6%) 5 (10.4%) 1 (2.1%)	14 (53.8%) 9 (34.6%) 3 (11.5%) 0 (0%)	9 (40.9%) 10 (45.5%) 2 (9.1%) 1 (4.5%)	$X^2(3)=2.03$	0.568	‡1.728 (0.505-5.912) §1.037 (0.144-7.478)
Canadian Angina Classification n (%) Class 1 ‡ Class 2 Class 3	27 (56.3%) 17 (35.4%) 4 (8.3%)	16 (61.5%) 8 (30.8%) 2 (7.7%)	11 (50.0%) 9 (40.9%) 2 (9.1%)	$X^2(2)=0.65$	0.720	‡ 1.636 (0.482-5.561) §1.455 (0.172-11.937)
Number Co-morbidities per Subject n (%) < 11 Co-morbidities‡ ≥ 12 Co-morbidities	37(77.1%) 11(22.9%)	22(84.6%) 4(15.4%)	15(68.2%) 7(31.8%)	$X^2(1)=1.82$	0.302	‡ 2.567 (0.638-10.334)
† All Subjects N=47, CAD n=25, T2DM+CAD n=22; ‡= reference from first to second category CAD-T2DM for calculating odds ratio. § = reference first to third category CAD-T2DM for calculating odds ratio.						

Table 4. Pre-rehabilitation program patient profile factors for the total sample and for subjects with coronary artery disease only (CAD, n=26)

and for subjects with type II diabetes plus coronary artery disease (T2DM+CAD, n=22).

Variables Median (Interquartile Range)	CAD (n =26)	T2DM + CAD (n=22)	Test Statistic	p-value	‡ Cohen's d	Effect Size Interpretation
Neo Five Factor Inventory †						
Neuroticism	16.0 (10)	18.0 (15.0)	U=344.5	0.126	d = -0.452	Medium
Extraversion	26.5(8.0)	28.0 (17.0)	U=283	0.830	d = -0.061	Small
Openness	22.0 (9.0)	24.0 (11.0)	U=356.5	0.073	d = -0.537	Medium
Agreeableness	35.0 (4.0)	32.0 (12.0)	U = 234	0.402	d = 0.240	Small
Conscientiousness	37.0 (9.0)	32.0 (12.0)	U=197	0.103	d = 0.485	Medium
Multi -Dimensional Health Locus of Control						
Internal	25.0 (11.3)	27.0 (9.0)	U=344	0.229	d = -0.349	Small
Chance	13.0 (12.5)	11.0 (6.0)	U=208.5	0.108	d = 0.477	Medium
Powerful Others	25.0 (4.0)	26.0 (7.0)	U= 313.5	0.568	d = -0.162	Small
Brief Cope						
Self –Distraction	4.0 (2.0)	4.0 (4.5)	U = 310	0.614	d = -0.144	Small
Active Coping	6.0 (3.0)	7.0 (2.5)	U = 327.5	0.378	d = -0.144	Small
Denial	2.0 (1.0)	2.0 (0.0)	U = 288	0.130	d = 0.000	Negligible
Substance use	2.0 (0.0)	2.0 (0.0)	U = 288	0.905	d = -0.034	Negligible
Emotional Support	5.5 (3.0)	6.0 (2.5)	U =305.5	0.682	d = -0.117	Small
Behavioral Disengagement	2.0 (0.0)	2.0 (0.0)	U = 291	0.829	d = -0.061	Small
Venting	2.5 (2.0)	4.0 (2.5)	U = 359.5	0.107	d = -0.472	Medium
Positive Reframing	4.5 (4.0)	6.0 (2.5)	U = 330.5	0.350	d = -0.271	Small
Planning	5.5 (3.0)	6.0 (2.0)	U = 299	0.785	d = -0.078	Small
Humor	3.0 (2.0)	3.0 (2.0)	U = 306	0.663	d = -0.121	Small
Acceptance	7.0 (2.0)	6.0 (3.0)	U = 260	0.578	d = 0.158	Small
Religion	5.5 (5.0)	5.0 (4.0)	U = 258.5	0.564	d = 0.167	Small
Interpersonal Support Evaluation List						
Appraisal	14.0 (2.0)	14.0 (3.5)	U=260.5	0.590	d = 0.154	Small
Tangible	15.0 (2.0)	15.0 (2.5)	U=282	0.932	d = 0.024	Negligible
Self-esteem	15.0 (2.0)	14.0 (4.0)	U=235.5	0.291	d = 0.314	Small
Belonging	16.0 (3.0)	16.0 (3.5)	U=313	0.571	d = -0.163	Small
Self-Efficacy for Exercise Scale						
Exercise Score	6.78 (2.86)	5.5(3.56)	U=199.5	0.073	d = 0.531	Medium
Key: † CAD n = 26, T2DM+CAD n= 21 ‡Cohen's D calculated as the standardized mean difference based on ranks of CAD-T2DM. The following social science guidelines for determining effect sizes were utilized; negligible $r \leq 0.049$ small effect size, $r = 0.05 - 0.349$; medium, $r = 0.35 - 0.55$ large, $r = 0.56$ or larger.						

Table 5. Post-Rehabilitation program clinical characteristics for the total sample (n=48) and in subjects with coronary artery disease only (CAD, n=26) and with type II diabetes plus coronary artery disease (T2DM+CAD, n=22).

Variables	All Subjects N = 48	CAD n = 26	T2DM + CAD n = 22	Test Statistic	p-value	Odds Ratio (95% Confidence Interval)
Hemoglobin A1C n (%)				$X^2(1)=9.93$	0.002	‡17.308 (1.972-151.890)
Normal < 6.4 mg/dl	38 (79.2%)	25 (96.2%)	13 (59.1%)			
Diabetes ≥6.4 mg/dl	10(20.8%)	1 (3.8%)	9 (40.9%)			
Hemoglobin A1C Range n (%)				$X^2(2)=13.9$	< 0.001	‡8.000 (0.894-71.578)
Normal < 5.7 mg/dl	11 (22.9%)	10 (38.5%)	1(9.1%)			§90.000 (4.881-16.590)
Pre-diabetes 5.71 -6.39 mg/dl	27 (56.3%)	15 (57.7%)	12 (54.5%)			
Diabetes ≥6.4 mg/dl	10 (20.8%)	1 (3.8%)	9 (40.9%)			
Body Mass Index n (%)				$X^2(1)=1.68$	0.195	‡3.000 (0.539-16.689)
0-24.9 normal	8 (16.7%)	6 (23.1%)	2 (9.1%)			
≥ 25 abnormal	40 (83.3%)	20 (76.9%)	20 (90.9%)			
Body Mass Index Range n (%)				$X^2(2)=2.59$	0.274	‡4.125 (0.654-26.200)
0-24.9 normal	8 (16.7%)	6 (23.0%)	2 (9.1%)			§2.250 (0.365-13.870)
25-29.9 overweight	19 (39.6%)	8 (30.8%)	11 (50.0%)			
≥ 30 obese	21 (43.8%)	12 (46.2%)	9 (40.9%)			
Waist to Hip Radius Range n (%)				$X^2(1)=1.05$	0.306	‡1.879 (0.558-6.326)
Small risk <0.96	32 (66.7%)	19 (73.1%)	13 (59.1%)			
High risk ≥0.96	16 (33.3%)	7 (26.9%)	9 (40.9%)			
‡=Reference category from first to second category CAD-T2DM for calculating odds ratio., § = Reference category first to third category for CAD-T2DM for calculating odds ratio. .						

Table 6. Group-specific descriptive and comparative statistics at pre and post rehabilitation program and the percentage of change over time for subjects with coronary artery disease only (CAD, n=26) and with type II diabetes plus coronary artery disease.

	Pre-Rehabilitation		p-value	‡Cohen's D	Post-Rehabilitation		p-value	‡Cohen's D	% change Pre to Post (within the cohort)		p-value	‡Cohen's D
Variables	CAD n=26	T2DM+CAD n=22			CAD n=26	T2DM+CAD n=22			CAD n=26	T2DM+CAD n=22		
Illness Severity												
Median (Interquartile Range)												
Hemoglobin A1C mg/dl	5.50 (0.50)	6.60 (0.97)	0.001	d=1.426	5.8 (0.70)	6.35 (1.35)	0.001	d=1.512	5.2%	-3.8%	0.045	d=0.512
Body mass index (%)	30.0 (7.40)	28.8 (7.62)	0.877	d=0.160	29.1 (7.6)	28.6 (7.49)	0.975	d=0.066	-3.1%	-0.70%	0.473	d=0.063
Waist to Hip Ratio (cm/in)	0.97 (0.11)	0.911(0.14)	0.717	d=0.469	0.91 (0.09)	0.950 (0.14)	0.934	d=0.339	-6.6%	4.1%	0.418	d=0.340
Systolic Blood pressure mm/Hg	122 (25.0)	136 (23.0)	0.075	d=0.583	118 (26.0)	129 (14.0)	0.073	d=0.529	-3.4%	-5.4%	0.432	d=0.527
Diastolic Blood pressure mm/Hg	70 (16.0)	70 (19.0)	0.646	d=0	66 (10.0)	70 (9.0)	0.247	d=0.420	-6.1%	0%	0.356	d=0.421
Jette Function Index Status												
Median (Interquartile Range)												
Assistance	0.139 (0.46)	0.167 (0.27)	0.867	d=0.074	0.000 (0.14)	0.111 (0.35)	0.370	d=0.464	0%	-50.1%	0.530	d=0.416
Pain	1.083 (0.38)	1.028 (0.42)	0.879	d=0.137	1.083 (0.24)	1.056 (0.29)	0.703	d=0	0%	2.7%	0.346	d=0.101
Difficulty	1.111 (0.46)	1.028 (0.42)	0.410	d=0.186	1.083 (0.28)	1.083 (0.35)	0.812	d=0	-2.5%	5.1%	0.431	d=0.000
Morisky Medication Adherence Score Mean(SD)	0.654 (0.629)	0.864 (0.940)	0.203	d=0.263	0.654 (0.629)	0.727(0.827)	0.693	d=0.099	0%	-18.7%	0.918	d=0.100
Rehabilitation Appointments Attended mean (SD)												
Appointments Scheduled	24 (0)	24 (0)		d=0	N/A	N/A		d=0.154	82.3%	85.7%	0.806	d=0.154
Appointments Attended	N/A	N/A			20.4 (4.7)	21(2.9)						
‡ Cohen's D calculated as standardized mean difference based on ranks was computed as CAD-T2DM. The following social science guidelines for determining effect sizes were utilized; negligible $r \leq 0.049$ small effect size, $r = 0.05 - 0.349$; medium, $r = 0.35 - 0.55$ large, $r = 0.56$ or larger.												

6.0 RESEARCH RESULTS AND DISCUSSION: SPECIFIC AIM 4

6.1 SPECIFIC AIM 4 PROGRESS AND COMMITTEE DECISION

The focus of Specific Aim 4 was to explore the main and interaction effects of both the Patient Profiles and Illness Contextual Factors within the T2DM+CAD and CAD patients groups on Program Adherence and Outcomes upon conclusion of a standard outpatient cardiac rehabilitation program.

To accomplish this goal, the statistical plan was to perform bivariate correlations and simple linear regression between illness contextual factors, patient profile factors, and program adherence and outcome variables based on significant relationships noted in the bivariate analyses. Next, multiple regression analyses was to be conducted to explore the main effects and two-way and three-way interaction effects of Illness Contextual factors, Patient Profile factors, and diabetes status on program adherence and outcome variables. In addition, effect sizes (regression coefficient with 95% confidence intervals) were to be estimated for each main effect and interaction effect. R-square statistics would be calculated to summarize the percentage of variance explained in the program adherence and outcome variables. Finally, residual analyses were to be performed to identify instances of model misspecification and influential observations.

Since the outcome variables were categorical, and the predictor variables were either continuous or categorical, logistic regression was chosen as the primary method to test main, two-way and three-way interactions.

However, there were very few statistically significant findings in the univariate analyses, which was not unexpected based on the sample size. Therefore, the committee determined that it would be premature to attempt regression analysis and made the decision not to proceed further in this Aim until a larger sample is recruited in a follow-up study.

APPENDIX A

REVIEW OF LITERATURE PERMISSION APPROVAL LETTER



DATE: 3/4/11

Joyce Miketic
120 Evergreen Road
Pittsburgh, PA 15238

Fee: \$0.00

Re: ***Journal of Cardiovascular Nursing***
Spec Mat: JCN, 2011; In-Press: JCN D10-00098R1
Author Request / To use in a PhD thesis

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Factors Influencing the Outcomes of Patients With Both Coronary Artery Disease and Diabetes Enrolled in Standard Cardiac Rehabilitation Programs

A Literature Review

Joyce K. Miketic, MBA, PhD(c), RN; Marilyn Hravnak, PhD, RN, ACNP-BC, FCCM, FAAN; Carol S. Stilley, PhD, RN; Robert J. Robertson, MA, PhD; Susan M. Sereika, PhD

Currently 23.5 million working-age adults 20 years or older have had a diagnosis of both coronary artery disease (CAD) and type 2 diabetes mellitus (T2DM), with estimates that an additional 9% of the total US population will have a diagnosis of this chronic disease combination by the year 2025. Current annual health care costs for this working-age population including medical costs, functional disability, work loss, and premature mortality currently exceed \$620 billion. Prior research efforts have shown that 25% to 32% of patients requiring a coronary revascularization procedure have both CAD and T2DM. The primary intervention prescribed for these patients to regain functional ability after revascularization is enrollment in a standard outpatient cardiac rehabilitation (CR) program. These standard programs, ranging in duration from 6 to 12 weeks, have been shown to improve the physical function of CAD patients by up to 15%, but patients diagnosed with both chronic conditions of CAD and T2DM (T2DM+CAD) attending these same programs exhibit only an 8% improvement. Moreover, T2DM+CAD patients experience much lower rates of rehabilitation program appointment adherence as well as greater program attrition (T2DM+CAD: 45%–62% vs CAD: 92%). Current medical literature regarding the relationship between CAD, T2DM, and cardiac rehabilitation will be examined to identify specific factors that could influence the functional outcomes achieved by the T2DM+CAD population when enrolled in a standard CR program and help increase understanding of why the adherence and attrition differences exist.

KEY WORDS: cardiac rehabilitation, coronary artery bypass graft, functional outcomes, rehabilitation outcomes, revascularization, type 2 diabetes mellitus

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Prevalence of Type 2 Diabetes Mellitus and Coronary Artery Disease

According to the American Diabetes Association's 2010 position statement, diabetes is a chronic condition that continues to influence both major public health and economic issues in the United States.^{1,2} Because of lifestyle preferences that promote physical inactivity and increasing rates of obesity, the number of Americans diagnosed with the most prevalent form of diabetes mellitus (DM) (type 2 or adult onset) is projected to increase from 21 million to 29 million in 2050.^{3–5} The underlying causes of type 2 DM (T2DM) result from a combination of impairment in insulin-mediated glucose disposal and insulin secretion by pancreatic beta cells.^{6,7} Type 2 DM, if left untreated, has been shown to be a strong contributor in the development of CAD.^{6,7}

The Healthy People 2010 Physical Activity Health Indicator reveals that currently 11% or 23.5 million

working-age adults 20 years or older have been diagnosed with both CAD and T2DM, with estimates that an additional 9% of the total US population will be diagnosed with this dual disease combination by the year 2025.⁸⁻¹⁰ Projected health care costs for this working-age population, including direct medical care costs and indirect costs (disability, work loss, premature mortality), currently exceed US \$620 billion.⁷ The risk of developing a myocardial infarction (MI) is 2 to 4 times greater in these individuals as compared with individuals diagnosed with only CAD.¹¹ There is also evidence that although the overall CAD mortality rates have decreased in the total US population, CAD mortality is not declining in the DM population.¹² Several studies have confirmed that 25% to 32% of all patients with MI requiring a revascularization procedure have both CAD and T2DM.^{13,14}

The primary intervention prescribed for these patients to regain functional ability after revascularization is enrollment in a standard outpatient cardiac rehabilitation (CR) program. These programs, ranging in duration from 6 to 12 weeks, have been shown to improve the physical function of CAD patients by up to 15%, but patients diagnosed with both chronic disease states of T2DM+CAD exhibit only an 8% improvement. Moreover, many research investigations have corroborated that T2DM+CAD patients experience much lower rates of rehabilitation program appointment adherence and greater attrition (T2DM+CAD: 45%–62% vs CAD: 92%).¹⁵⁻¹⁷ Therefore, the purpose of this T2DM+CAD literature review was to enhance the nurses' understanding of potential factors that may influence this unique population's functional outcomes before and after enrollment in a standard CR program.

Methods

Original articles published in the English language were identified through an OVID and MEDLINE literature search conducted for the years of 1996 to 2010. The following key terms were utilized alone or in combination for the specific literature search: *diabetes mellitus, type 2 diabetes mellitus, cardiovascular disease, coronary artery disease, cardiac rehabilitation, functional outcomes, disability, physical activity, adherence, revascularization, and coronary artery bypass graft*.

All the articles examined were studies based on exploring some aspect of the relationship between coronary heart disease, T2DM, and CR. Because only English-translated research articles were examined, this literature review may have missed some documentation discussing significant findings between the combined coronary artery disease (CAD), T2DM+CAD, and CR evidence from foreign medical research investigations. In addition, recent position papers on

diabetes and cardiovascular disease were reviewed to provide a comprehensive review of the current medical standards of care for both the CAD and T2DM patient population.

From this literature search, 4 major areas appeared to emerge concerning the relationship between coronary heart disease, T2DM and CR. The first area was the relationship investigated between the concept of overall functional disabilities and the chronic disease state of T2DM. The second area was research involving the examination of the association of exercise and T2DM. The third area included exploration in the pathophysiological patterns present in patients with T2DM+CAD. The final area, which yielded the smallest percentage of research articles, was an inquiry into documented outcomes of T2DM+CAD in CR programs.

Focus Area 1: Functional Disability and T2DM

Functional disability defined as difficulty performing daily living and routine social or work-related activities is highly prevalent in individuals diagnosed with chronic diseases such as DM.¹⁸ Several studies conducted between 1999 and 2005 investigated this specific functional relationship between T2DM and disability.

Gregg et al¹⁸ found in their analysis of the Third National Health and Nutrition Examination Survey (NHANES III) data that 1.2 million US adults (one-fourth of population from the NHANES sample) were diagnosed with T2DM and unable to do simple mobility tasks defined as walking one-fourth of a mile. Moreover, the NHANES T2DM population demonstrated slower walking speeds, chair-stand performances, and balance positioning abilities.¹⁸ Gregg et al¹⁸ associated the decline in these higher physical activities to be due to both diabetic complications (retinopathy and neuropathy) and associated coronary heart disease comorbidities such as microvascular disease.

Gregg et al¹⁹ later went on to utilize data from a study of osteoporotic fractures, in which they analyzed both intrinsic (obesity, hyperglycemia) and extrinsic (coronary heart disease, peripheral vascular disease) factors to determine the extent of functional disability in older women with T2DM. This specific research investigation demonstrated that the development of functional disabilities in performing routine bathing, dressing, or low-impact mobility tasks was doubled (10%) for women with T2DM as compared with women without T2DM (5%) caused by sociodemographic classification and access to health care.¹⁹

The research of Blaum et al²⁰ classified older adults into high-, intermediate-, and low-functioning individuals with and without diagnosed T2DM and followed their performance activity levels for 2 years. Data were obtained from the Study of Assets and Health

Dynamics Among the Oldest Old, a longitudinal study of a nationally representative cohort of persons 70 years or older living in a community setting.²⁰ High-functioning individuals were defined as reporting no limitations in tasks involving physical functioning tasks (walking several blocks, climbing one flight of stairs, lifting 10 lb), instrumental activities of daily living tasks (taking medications, using the telephone, managing money), and personal care tasks (dressing, bathing, toileting, eating).²⁰ Thirty-nine percent of this population had T2DM. Intermediate-functioning adults demonstrated difficulties in 2 of the 3 functional categories, with T2DM comprising 36% of the total intermediate population.²⁰ Low-functioning adults reported limitations in all 3 functioning categories, and as expected in the sample size calculation, 24% of adults were diagnosed with T2DM.²⁰

This 2-year investigation revealed that 25% of T2DM adults continued to enjoy high functioning status but showed a significantly higher rate for the development of cardiovascular disease than people without DM.²⁰ The characteristics of this high-functioning T2DM group revealed that they were younger, had a higher educational level, and had better access to chronic disease care, allowing them to practice preventive disease behaviors as prescribed by their health care team.²⁰ Those T2DM subjects who were initially defined as low functioning exhibited minor changes in their functional status for the 2-year study participation time, whereas intermediate-functioning adults displayed the greatest change in routine performing all requiring physical functioning, instrumental activities of daily living, and personal care tasks.²⁰

Two notable conclusions can be drawn from this study. First, the nondecline in functional status for high-functioning patients with diabetes may be related to the good preventive health care practices of this group. Second, the decline in the intermediate functioning population may be correlated with the progressive development of complications associated with microvascular degeneration and associated comorbidities such as CAD.²⁰

Research by Egede¹⁵ focused on the connection between functional disability, T2DM, and depression. Data used in this study came from the National Health Interview Survey. Several important conclusions resulted from this study. Individuals with T2DM developed major depressive episodes at more than 2 times greater the rate (58.1%) than individuals without DM (24.5%).¹⁵ Type 2 DM subjects with other comorbidities such as CAD or congestive heart failure developed major depressive episodes at 3 times the rate (77.8%) compared with nondiabetic individuals.¹⁵

A study that confirms Egede's findings that depressive illness is strongly associated with disease complications and work disability was conducted by Von Koref et al.²¹ Twenty-four percent of their enrolled

T2DM subjects reported that they had experienced either a minor or major depressive episode, with 19% indicating that the depressive incident resulted in significant work disabilities (defined as missing >5 days of work per month).²¹

Continuing with the investigational theme of functional disability, the research of Mayfield et al²² used data obtained from the National Medical Expenditures Survey 2 and investigated the sole concept of "work disability" in T2DM. This form of disability was defined as a complex interaction of health conditions, functional status, special work requirements, and available economic alternatives.²² Thirty percent of the women with T2DM were classified as work disabled.²² In addition, work disability or functional impairment rates between male and female patients with diabetes were found to differ by only 5%.²² However, the research of Sanderson et al²³ reported that the main deterrent preventing women from attending a CR program was low income and education, not disability.

Therefore, these studies on the functional disabilities of patients with T2DM clearly indicate some of the profound and detrimental influences (preventive health practices, sociodemographic status, sex, and education) that eventually lead to the chronic disease complications and comorbid disease progressions that cause T2DM individuals to be eventually classified as severely impaired.

Focus Area 2: Exercise and Diabetes

The American Diabetes Association and the American College of Cardiology issued a combined statement about the benefits of T2DM individuals participating in routine exercise programs. Persons with diabetes who regularly engage in physical activity improve their glycemic control by stimulating glucose utilization and improving insulin sensitivity and glucose uptake in muscles, resulting in a decline in blood glucose.²⁴ A single bout of aerobic exercise on insulin sensitivity may last as long as 24 to 72 hours and reduce hemoglobin A_{1C} (HgbA_{1C}) levels by 0.66%.²⁴ Physically active persons with diabetes also have been shown to exhibit lower blood pressures readings, increased high-density lipoprotein cholesterol levels, decreased triglyceride levels, and decreased anxiety and depression episodes.^{25–28} These factors are favorable to protect patients with not only diabetes against the development of diabetic complications, but also cardiovascular disease as well.

The position on exercise activity for persons with diabetes was developed by examining the results of current studies such as the 2003 investigation of Loimaala et al²⁹ on the effects of exercise training on glycemic control, cardiovascular performance, and systemic vascular resistance in T2DM population. This study showed that

for vascular disease in T2DM patients. Like Gregg, their primary data source came from NHANES III. They compared data on T2DM+CAD subjects collected from both the NHANES and NHANES III investigations. In looking at these comparisons of standardized treatment recommendations for control of vascular complications, they chose to analyze Hgb A_{1C}, blood pressure, and total serum cholesterol levels. The overall mean value Hgb A_{1C} levels did not change over time from NHANES (7.7%) to NHANES III (7.6%)—a span of 12 years.³⁷ Additionally, the overall mean blood pressure values did not substantially change from NHANES (138/74 mm Hg) to NHANES III (131/73 mmHg).³⁷ However, 66.1% of NHANES subjects had cholesterol levels greater than 200 mg/dL as compared with 52% of subjects from NHANES III study.³⁷ Thus, she concluded that medical treatment practice pattern changes for the prevention of vascular disease in T2DM patients had been changed only slightly over time and that further health efforts are needed to control risk factors for cardiovascular disease among individuals diagnosed with T2DM.³⁷

In addition to NHANES study, Mehler et al³⁸ investigated the adequacy of treatment of hyperlipidemia in patients with T2DM enrolled in the Appropriate Blood Pressure Control in Diabetes trial. He found that only 19% of the 133 patients with known CAD had a low-density lipoprotein cholesterol level less than 100 mg/dL at baseline, and only 16% achieved this level at the completion of the study ($P = .37$), suggesting that hyperlipidemia is being treated suboptimally in this combined chronic disease population.³⁸

In summary, these research articles on the pathophysiological patterns in T2DM+CAD research have validated the synergistic link between these 2 chronic disease states, but further efforts must be made to implement health treatment changes for these conditions by the health care community.

Focus Area 4: Cardiac Rehabilitation Outcomes of Patients With T2DM+CAD

Coronary artery bypass grafting (CABG) or coronary revascularization has been the treatment of choice to correct the atherosclerosis complications present in the T2DM population as evidenced by several studies.³⁹⁻⁴¹ However, limited research studies have been performed on how to achieve a successful rehabilitation recovery in this specialized patient population.

Pennell et al⁴² emphasized that a successful outcome after CABG starts with presurgical treatment practices such as implementing a strict glycemic initiative. Using data collected on 103 post-CABG patients in an eastern US hospital, Pennell et al⁴² found that by utilizing a glycemic practice plan, the length of stay for the T2DM+CAD patients was reduced by 1.2 days,

6.7% of the T2DM+CAD patients developed postoperative infections, and only 2 patients died.

Along the same research outcome focus of glycemic control, Verges et al¹⁶ enrolled 59 T2DM patients in a 2-month CR program to determine if these diabetic patients could obtain an increase in exercise capacity (maximal oxygen consumption = $\dot{V}O_{2max}$) as patients with no diabetes after revascularization procedure.¹⁶ They found that no significant pre-cardiac program differences existed between the T2DM and non-DM groups in terms of left ventricular function, type of coronary event, site of MI, use of cardiovascular drugs, prevalence of hypertension, and smoking history.¹⁶ However, the body mass index was slightly higher in the T2DM group as compared with the non-DM (28.3 vs 24.9 kg/m³).¹⁶ After completion of the rehabilitation program, Verges et al¹⁶ found that changes in peak $\dot{V}O_{2max}$ for the diabetic group were significantly and inversely correlated with their fasting blood glucose levels; that is, the lower the blood glucose, the higher the exercise capacity ($r = 0.40$, $P = .002$). They therefore concluded that the response to CR by T2DM patients may be influenced by blood glucose levels.¹⁶

The research of Yu et al⁴⁰ continued this focus on glycemic control outcomes of T2DM patients participating in CR exercise programs. In a cohort of 418 patients enrolled in CR, the mean age was 64 years, 32% were diagnosed with T2DM, 70% of enrolled subjects were male, and 49% were diagnosed with hypertension.⁴⁰ Their results showed that the rehospitalization rate for T2DM+CAD patients was significantly longer than for CAD-only patients (T2DM+CAD: 2.3 days vs CAD: 1.6 days, $P = .04$); hospitalization length of stay was doubled (T2DM+CAD: 25.5 days vs CAD: 11.4 days; $P = .02$), and a significant trend was noted toward increasing fasting blood sugar levels for the T2DM+CAD patients as their participation in the CR program progressed (T2DM pre-CR: 7.9 mmol vs T2DM post-CR: 9.0 mmol; $P = .11$).⁴⁰ However, no change in glucose levels in the CAD-only population was present. (non-DM pre-CR: 5.4 mmol vs non-DM post-CR: 5.4 mmol; $P = .23$).⁴⁰ So, based on the results of the study of Yu et al,⁴⁰ it is recommended that strict glycemic monitoring of T2DM patients during CR be initiated.

The studies of Dylewicz et al⁴³ promoted short-term endurance training consisting of bouts of cycling for their research on glycemic control in the post-CABG T2DM population. Their premise was that this exercise would modify the carbohydrate metabolism because of the increase in binding and degradation of the ¹²⁵I-insulin erythrocyte receptors will decrease insulin resistance. Results from this study found that their hypothesis was correct. Blood glucose levels dropped from 111.2 mg/dL before CR exercises to 97.8 after CR exercises.⁴³ Moreover, an increase in

insulin binding was noted 0.535 to 0.668 pg.⁴³ They concluded that CR programs designed with short-term endurance exercise induced favorable changes in glycemic control in the T2DM population.⁴³

The research of Banzer et al⁴⁴ on the characteristics of CR in patients with T2DM addressed the adherence to CR program issue. In an investigation on 952 patients enrolled in a 10-week CR program, they found that 26% of the population was diagnosed with T2DM, and 53% of these subjects were taking insulin and/or an oral hypoglycemic agent. Type 2 DM+CAD patients had a significantly lower exercise capacity at entry than CAD-only patients (T2DM+CAD: 5.7 METs vs CAD: 7.0 METs; $P < .00001$).⁴⁴ Body mass indices of the T2DM+CAD population were also higher than the CAD population (T2DM+CAD: 34.1 vs CAD: 30.8; $P < .0001$).⁴⁴ Most astonishingly, post-CR program results indicate that T2DM+CAD patients had a 62% dropout rate and withdrew from the program more often because of an exacerbation of medical problems.⁴⁴

Soja et al⁴⁵ demonstrated that by using an intense multifactorial intervention that focused on individualized diabetic education sessions, improvements in both exercise capacities and reductions in both blood pressure and Hgb A_{1C} levels resulted in improved post-CR program outcomes for the T2DM+CAD population. In DANSUK (Danish Study of Impaired Glucose Metabolism), 104 patients with T2DM+CAD were followed up in a 1-year intense CR program that consisted of intense nutritional counseling, cooking, smoking cessation, psychological support, pharmacological, risk factor management, and exercise classes.⁴⁵ In addition, a 24-hour telephone help line manned by a trained staff was provided as well as consultations with physicians and nurses trained in internal medicine and cardiology.⁴⁵ After the completion of this program, Hgb A_{1C} levels decreased by 0.65% ($P < .05$), allowing at least 67% of the enrolled T2DM+CAD patients to reach the optimal glycemic goal set at 6.5% Hgb A_{1C}.⁴⁵ Thus, it was determined that an intense multipronged CR intervention program is the best method for treating T2DM+CAD patients.⁴⁵

Some of the most interesting research on T2DM+CAD patients participating in CR programs has been conducted by Lavie and Milani.^{46,47} These seasoned researchers recognized that T2DM+CAD patients may have long-standing complications such as peripheral neuropathy, retinopathy, autonomic neuropathy, and peripheral vascular disease. Their research revealed, like DANSUK, that each of these complications needs to be addressed by an individualized CR plan.^{46,47} For example, they found that T2DM+DM patients with peripheral vascular disease may utilize cycle ergometry and arm ergometry exercises to replace the traditional treadmill walking.⁴⁶ In addition, Lavie and

Milani⁴⁶ investigated the psychological behaviors exhibited by T2DM+CAD patients in CR programs. Persons with diabetes demonstrated a higher incidence of depression (T2DM+CAD: 26% vs CAD: 14%; $P < .03$). They concluded that screening for depression prior to any active participation in a CR program is an essential assessment for the T2DM patient.⁴⁶ These findings were interesting because in a study conducted by Maniar et al⁴⁸ on the typical CAD-focused rehabilitation population, older patients with CAD who began a CR program showed higher comorbidity burdens, but displayed decreased depression index scores.

In a more recently published article, Mourout et al⁴⁹ reported that prior to beginning a CR program, T2DM patients with CAD showed a higher prevalence of cardiovascular disease risk factors such as hypertension and hypercholesterolemia and overall poorer physical attributes as demonstrated by their body composition measurements than patients with CAD-only patients. Moreover, rates of depression were higher in the T2DM+DM group as compared with the CAD-only group.⁴⁹ But both patient groups demonstrated significant improvements at the end of their CR programs in overall exercise capacities and body composition measurements.⁴⁹

In the last study reviewed, Völler et al⁵⁰ followed up patients with T2DM+CAD and CAD only to specifically track the physiological changes that these patients exhibit from hospitalization through CR program completion. They specifically examined physiological characteristics of blood pressure, lipid and glucose levels, and their relationship to specific pharmacological and general treatment management standards.⁵⁰ They found that although improvements were made in reducing hyperlipidemia, hypertension and hyperglycemia control was not as successful, nor were hypertension and hyperglycemia being treated according to guideline recommendations.⁵⁰ They concluded that to have patients achieve optimal CR program goals for both T2DM+CAD patients and CAD patients, a multi-interventional treatment plan consisting of regular physical activity, healthy diet, and guideline-oriented drug-based therapy must be initiated by medical care providers and strictly followed by the CR team.⁵⁰

Thus, these research investigations have shown that T2DM patients may start a CR program with inadequate glycemic control and poorer physical attributes, but a comprehensive individualized education and exercise program conducted by an interdisciplinary team may alleviate or prevent further cardiovascular and glycemic complications.

Review Limitations

The main limitation in conducting this review is that few research studies have examined the specialized

Clinical Pearls

- Research has proven that all forms of physical activity, including the simple act of walking, can improve the glycemic control of a patient with diabetes and reduce their risk for further cardiovascular complications.
- Screening for depression prior to any active participation in a CR program is an essential assessment for the CAD/diabetic patient.
- Development of a CR interdisciplinary program focusing on aggressive glycemic control measures, nutritional plans, and participant-specific short-term endurance exercises provides improved outcomes for the diabetic patient.
- Development of medical-work partnerships at both the primary care and rehabilitation levels can promote overall cardiovascular health in the diabetic and prediabetic populations.

patient population with the dual diseases of CAD and T2DM in the CR setting. Other limitations are that some of the reported studies had small participant populations from distinct areas, and their characteristics may not reflect the general characteristics of the overall CR population. Most importantly, many T2DM patients present to a CR program with additional medical conditions such as osteoporosis, nephropathy, retinopathy, or neuropathy, and the effects of these comorbidities in comparison to the typical CAD patient have not been fully investigated in the CR environment.

Conclusion

All of these research studies described in the 4 focus areas indicate that to accurately prepare the T2DM+CAD patient for participation in a CR program, a total understanding of the individual's physiological, socio-demographic, and psychological dynamic patterns must be studied in detail. Thus, the following strategies may be considered to improve CR outcomes for T2DM+CAD patients:

- Development of comprehensive pre-CR assessment tools specifying the T2DM+CAD patients' socio-demographic, medical, psychological (depression), and pre-exercise conditions
- Development of a CR interdisciplinary program focusing on aggressive glycemic control measures, nutritional plans, and participant-specific short-term endurance exercises
- Development of medical-work partnerships at both the primary care and rehabilitation levels designed to promote overall cardiovascular health in the diabetic and prediabetic populations
- Continued research efforts designed to examine not only how specific diabetic comorbid conditions affect overall T2DM+CAD patients' CR outcomes but also behavioral-based variables as well

- The implementation of these strategies can be the starting point for both improved outcome and treatment adherence goals for this very special T2DM+CAD population

REFERENCES

1. American Diabetes Association. Standards of medical care in diabetes—2010. *Diabetes Care*. 2010;33(S1):S11–S61.
2. Songer TJ. *Studies on the Costs of Diabetes*. Atlanta, GA: Centers for Disease Control and Prevention; Division of Diabetes Translation; 1998:259–282.
3. Boyle JP, Honeycutt AA, Venkat-Narayan KM, et al. Projection of diabetes burden through 2050. *Diabetes Care*. 2001;24(11):1936–1940.
4. American Diabetes Association. Economic costs of diabetes in the United States in 2002. *Diabetes Care*. 2003;26(3):917–943.
5. US Department of Health and Human Services. *Diabetes, Disabling Disease to Double by 2050*. Atlanta, GA: CDC; Coordinating Center for Health Promotion. 2008;1:1–4.
6. Grundy SM, Howard B, Smith S, et al. Prevention Conference VI: diabetes and cardiovascular disease: executive summary: conference proceeding for healthcare professionals from a special writing group of the American Heart Association. *Chest*. 2002;105:2231–2239.
7. Bergenstal RM, Bloomgarden Z, Charron-Prochownik D. *Understanding Cardiometabolic Risk: Broadening Risk Assessment and Management*. Alexandria, VA: American Diabetes Association; 2007.
8. National Center for Chronic Disease Prevention and Health. Leading health indicators. 2008. <http://www.healthypeople.gov>. Accessed July 12, 2008.
9. National Center for Health Statistics. Diabetes statistics. 2008. <http://www.cdc.gov/nchs/fastats/diabetes.htm>. Accessed February 22, 2009.
10. National Center for Chronic Disease Prevention and Health. Healthy People 2020 Public Meetings 2009 draft objectives. 2009. <http://www.healthypeople.gov/HP2020/>. Accessed September 13, 2010.
11. Egede LE, Zheng D. Modifiable cardiovascular risk factors in adults with diabetes. *Arch Intern Med*. 2002;162:427–433.
12. Gu K, Crowie CC, Harris MI. Diabetes and decline in heart disease mortality in US adults. *JAMA*. 1999;281:1291–1297.
13. Sahakyan K, Abranson JL, Krumholz HM, Vaccarino V. Comparison of functional status after coronary artery bypass grafting in patients with and without diabetes mellitus. *Am J Cardiol*. 2006;98:619–623.
14. Julien J. Cardiac complications in non-insulin dependent diabetes mellitus. *J Diabet Complications*. 1997;11(2):123–130.
15. Egede LE. Diabetes, major depression, and functional disability among US adults. *Diabetes Care*. 2004;27:421–428.
16. Verges B, Patois-Verges B, Cohen M. Effects of cardiac rehabilitation on exercise capacity in type 2 diabetic patients with coronary artery disease. *Diabet Med*. 2004;21:889–895.
17. Hindman L, Falko JM, LaLonde M, Snow R, Caulin-Glaser T. Clinical profile and outcomes of diabetic and nondiabetic patients in cardiac rehabilitation. *Am Heart J*. 2005;150:1046–1051.
18. Gregg EW, Beckles GL, Williamson DF, et al. Diabetes and physical disability among older US adults. *Diabetes Care*. 2000;23:1272–1277.
19. Gregg EW, Mangione CM, Cauley JA, et al. Diabetes and incidence of functional disability in older women. *Diabetes Care*. 2002;25:61–67.

20. Blaum CS, Ofstedal MB, Langa KM, Wray LA. Functional status and health outcomes in older Americans with diabetes mellitus. *J Am Geriatr Soc.* 2003;51:745-753.
21. Von Korf M, Katon W, Lin EH, et al. Work disability among individuals with diabetes. *Diabetes Care.* 2005;28:1326-1332.
22. Mayfield JA, Deb P, Whitecotton L. Work disability, and diabetes. *Diabetes Care.* 1999;22:1105-1109.
23. Sanderson BK, Shewchuk RM, Bittner V. Cardiac rehabilitation and women. *J Cardiopulm Rehabil Prev.* 2010;30:12-21.
24. American Diabetes Association /American College of Cardiology. Prescribing physical activity for the management of cardiovascular disease and diabetes. *Diabetes Cardiovasc Rev.* 2004;8:1-7.
25. Chipkin SR, Klugh SA, Chasan-Taber L. Exercise and diabetes. *Cardiol Clin.* 2001;19(3):1-22.
26. Eyre H, Kahn R, Robertson RM. Preventing cancer, cardiovascular disease and diabetes. *Diabetes Care.* 2004;27(7):1812-1824.
27. Cauza E, Hanusch-Enserer U, Strasser B, et al. The metabolic effects of long term exercise in type 2 diabetes patients. *Wien Med Wochenschr.* 2006;156(17-18):515-519.
28. Tekin G, Tekin A, Canatar T. Simvastatin improves attenuated heart rate recovery of type 2 diabetics. *Pharmacol Res.* 2006;54:442-446.
29. Loimaala A, Huikuri HV, Koobi T, et al. Exercise training improves baroreflex sensitivity in type 2 diabetes. *Diabetes.* 2003;52:1837-1842.
30. Sigal RJ, Kenny GP, Boule NG, et al. Effects of aerobic training, resistance training, or both on glycemic control in type 2 diabetes. *Ann Intern Med.* 2007;147:357-369.
31. Barrett JE, Plonikoff RC, Courneya KS, Raine KD. Physical activity and type 2 diabetes. *Diabetes Educ.* 2007;33(1):128-143.
32. Grundy SM, Benjamin IJ, Burke GL, et al. Diabetes and cardiovascular disease: a statement for healthcare professionals from the American Heart Association. *Circulation.* 1999;100:1134-1146.
33. Rosano GM, Vitale C, Fragasso G. Metabolic therapy for patients with diabetes mellitus and coronary artery disease. *Am J Cardiol.* 2006;98(suppl):14J-18J.
34. George PB, Tobin KJ, Corpus RA, et al. Treatment of cardiac risk factors in diabetic patients: how well do we follow the guidelines. *Am Heart J.* 2001;142:857-856.
35. Bowden DW, Rudock M, Ziegler J, et al. Coincident linkage of type 2 diabetes, metabolic syndrome, and measures of cardiovascular disease in a genome scan of the diabetes heart study. *Diabetes.* 2006;55:1985-1994.
36. Rachmani R, Levi Z, Slavachevski I, Avin M, Ravid M. Teaching patients to monitor their risk factors retards the progression of vascular complication in high-risk patients with type 2 diabetes mellitus- a randomized prospective study. *Diabetes Med.* 2002;19:385-392.
37. Saydah S, Franklin J, Cowie CC. Poor control of risk factors for vascular disease among adults with previously diagnosed diabetes. *JAMA.* 2004;291:335-342.
38. Mehler PS, Esler A, Estacio RO, et al. Lack of improvement in the treatment of hyperlipidemia among patient with type 2 diabetes. *Am J Med.* 2003;114:377-382.
39. Flaherty JD, Davidson CJ. Diabetes and coronary revascularization. *JAMA.* 2005;293:1501-1508.
40. Yu C, Lau C, Cheung B, et al. Clinical predictors of morbidity and mortality in patients with myocardial infarction or revascularization who underwent cardiac rehabilitation, and importance of diabetes mellitus and exercise capacity. *Am J Cardiol.* 2000;85:344-349.
41. Anselmino M, Malmberg K, Öhrvik J. Evidence-based medication and revascularization: powerful tool in the management of patients with diabetes and coronary artery disease: a report from the Euro heart survey on diabetes and the heart. *J Cardiopulm Rehabil Prev.* 2008;15:16-223.
42. Pennell L, Smith-Snyder CM, Hudson LR, Hamar GB, Westerfield J. Practice changes in glycemic management and outcomes in coronary artery bypass surgery patients. *J Cardiovasc Nurs.* 2005;20(1):26-34.
43. Dylewicz P, Bienkowska S, Szczesniak L, et al. Beneficial effect of short term endurance training on glucose metabolism during rehabilitation after coronary bypass surgery. *Chest.* 2000;117:47-51.
44. Banzer JA, Maguire TE, Kennedy CM, O'Malley CJ, Balady GJ. Results of cardiac rehabilitation in patients with diabetes mellitus. *Am J Cardiol.* 2004;93:81-84.
45. Soja AM, Zwisler AD, Frederiksen M, et al. Use of intensified comprehensive cardiac rehabilitation to improve risk factor control in patients with type 2 diabetes mellitus or impaired glucose tolerance-the randomized DANish StUdy of impaired glucose metabolism in the settings of cardiac rehabilitation (DANSUK) study. *Am Heart J.* 2007;153:621-628.
46. Lavie CJ, Milani RV. Cardiac rehabilitation and exercise training programs in metabolic syndrome and diabetes. *Card Rehabil Exerc Train.* 2005;25:59-66.
47. Milani RV, Lavie CJ. Behavioral differences and effects of cardiac rehabilitation in diabetic patients following cardiac events. *Am J Med.* 1996;100:517-523.
48. Maniar S, Sanderson BK, Bittner V. Comparison of baseline characteristics and outcomes in younger and older patients completing cardiac rehabilitation. *J Cardiopulm Rehabil Prev.* 2009;29:220-229.
49. Mourout L, Boussuges A, Maunier S, et al. Cardiovascular rehabilitation in patients with diabetes. *J Cardiopulm Rehabil Prev.* 2010;30:157-164.
50. Völler H, Reibis R, Pittrow D, et al. Secondary prevention of diabetic patients with coronary artery disease in cardiac rehabilitation: risk factors, treatment and target level attainment. *Curr Med Res Opin.* 2009;25:879-890.

APPENDIX B

INSTITUTIONAL REVIEW BOARD APPROVAL LETTER



University of Pittsburgh
Institutional Review Board

3500 Fifth Avenue
Pittsburgh, PA 15213
(412) 383-1480
(412) 383-1508 (fax)
<http://www.irb.pitt.edu>

Memorandum

To: Joyce Miketic
From: Christopher Ryan, PhD , Vice Chair
Date: 11/23/2009
IRB#: PRO08110261
Subject: Diabetic Coronary Heart Patients' Adherence to Cardiac
Rehabilitation Programs

The University of Pittsburgh Institutional Review Board reviewed and approved the above referenced study by the expedited review procedure authorized under 45 CFR 46.110 and 21 CFR 56.110.

Your research study was approved under:
45 CFR 46.110.(2)(a), 45 CFR 46.110.(7).

Approval Date: 11/20/2009

Expiration Date: 11/19/2010

For studies being conducted in UPMC facilities, no clinical activities can be undertaken by investigators until they have received approval from the UPMC Fiscal Review Office.

Please note that it is the investigator's responsibility to report to the IRB any unanticipated problems involving risks to subjects or others [see 45 CFR 46.103(b)(5) and 21 CFR 56.108(b)]. The IRB Reference Manual (Chapter 3, Section 3.3) describes the reporting requirements for unanticipated problems which include, but are not limited to, adverse events. If you have any questions about this process, please contact the Adverse Events Coordinator at 412-383-1480.

The protocol and consent forms, along with a brief progress report must be resubmitted at least one month prior to the renewal date noted above as required by FWA00006790 (University of Pittsburgh), FWA00006735 (University of Pittsburgh Medical Center), FWA00000600 (Children's Hospital of Pittsburgh), FWA00003567 (Magee-Womens Health Corporation), FWA00003338 (University of Pittsburgh Medical Center Cancer Institute).

Please be advised that your research study may be audited periodically by the University of Pittsburgh Research Conduct and Compliance Office.

APPENDIX C

JEFFERSON REGIONAL MEDICAL CENTER APPROVAL LETTER

JEFFERSON
REGIONAL MEDICAL CENTER

Medical excellence closer to home

March 20, 2008


Joyce K. Miketic
120 Evergreen Road
Pittsburgh, PA. 15238-2216

Dear Ms. Miketic,

I am writing to confirm that in the upcoming months you will be working with the Cardiovascular Serviceline at Jefferson Regional Medical Center. You will be working to complete your PhD dissertation titled, "Utilization of a Chronic Disease Adherence Model in a Diabetic Cardiac Rehabilitation Population.," through data review and collection.

We look forward to working with you.

Sincerely,



Sang B. Park, M.D.

Medical Director, Cardiovascular Surgery

BIBLIOGRAPHY

- American College of Sports Medicine. (2006) ACSM's guidelines for exercise testing and prescription, Lippincott, Williams & Wilkins: New York.
- American Diabetes Association /American College of Cardiology. (2004) Prescribing physical activity for the management of cardiovascular disease and diabetes. *Diabetes and Cardiovascular Review*. 8;1-7.
- American Diabetes Association. (2003) Economic Costs of Diabetes in the United States in 2002. *Diabetes Care*. 26;3: 917-943.
- American Diabetes Association. (2010) Standards of Medical Care in Diabetes 2010. *Diabetes Care*.33;S1:S11-S61.
- American Diabetes Association /American College of Cardiology. (2004) Prescribing physical activity for the management of cardiovascular disease and diabetes. *Diabetes and Cardiovascular Review*.8;1-7.
- Arrigo I, et.al. (2008) Comparative outcome one year after formal cardiac rehabilitation: the effects of a randomized intervention to improve exercise adherence. *European Journal of Cardiovascular Preventions and Rehabilitation*.15;306-311.
- Bays HE. et.al. (2007) The relationship of body mass index to diabetes mellitus, hypertension, and dyslipidemia: comparison of data from two national surveys. *International Journal of Clinical Practice*.61;737-747.
- Bai YL, et.al. (2009) Self-care behavior and related factors in older people with type 2 diabetes. *Journal of Clinical Nursing*. 18;3308-3315.
- Banzer JA.,Maguire TE., Kennedy CM., O'Malley.J., & Balady G.J. (2004) Results of cardiac rehabilitation in patients with diabetes mellitus. *The American Journal of Cardiology*. 93; 81-84.
- Barrett JE. (2007) Physical activity and type 2 diabetes. *Diabetes Educator* .33; 128-143.
- The BARI 2D study group. (2009)A randomized trial of therapies for type 2 diabetes and coronary artery disease. *New England Journal of Medicine*.360;2503-2515.

- Beswick AD, et.al. (2005) Improving uptake and adherence in cardiac rehabilitation: literature review. *Journal of Advanced Nursing*. 49;5:538-555.
- Bergenstal RM, Bloomgarden Z, Charron-Prochownik D. (2007) *Understanding Cardiometabolic Risk: Broadening Risk Assessment and Management*. Alexandria, Virginia: American Diabetes Association.
- Blaum CS, et.al. (2003) Functional status and health outcomes in older Americans with diabetes mellitus. *Journal of the American Geriatric Society*. 51;745-753.
- Brown LC, et. al. (2004) Evidence of suboptimal management of cardiovascular risk in patients with type 2 diabetes mellitus and symptomatic atherosclerosis. *CMAJ*. 171;10:1189-1192.
- Bowden DW, et. al. (2006) Coincident linkage of type 2 diabetes, metabolic syndrome, and measures of cardiovascular disease in a genome scan of the diabetes heart study. *Diabetes*. 55;1985-1994.
- Boyle JP, et. al. (2001) Projection of diabetes burden through 2050. *Diabetes Care*; 24 (11); 1936-1940.
- Canadian Cardiovascular Society. (1976) Cardiovascular Society—functional classification severity of unstable angina. *Circulation*. 54;522.
- Carver C. (1990) You want to measure coping but your protocol's too long: consider the brief cope. *International Journal of Behavioral Medicine*. 4;92-100.
- Cassar A, et.al. (2009) Chronic coronary artery disease: diagnosis and management. *Mayo Clinical Procedures*. 84;12:1130-1146.
- Cauza E, et. al. (2006) The metabolic effects of long term exercise in type 2 diabetes patients. *Wiener Medizinische Wochenschrift*. 156;515-519.
- Chipkin SR, Klugh SA, Chasan-Taber L. (2001) Exercise and Diabetes. *Cardiology Clinics* 19;3:1-22.
- Christensen A. (2000) A patient-by-treatment context interaction in chronic disease: a conceptual framework for the study of patient adherence. *Psychosomatic Medicine*. 62; 435-443.
- Christensen A. (1997) Monitoring attentional style and medical regimen adherence in hemodialysis patients. *Health Psychology*. 16;256-262.
- Christensen AJ, et. al. (1998) Psychomatic research in end-stage renal disease: a framework for matching patient to treatment, *Journal of Psychosomatic Research*. 44;523-558.
- Cohen S. & Hoberman HM. (1983) Positive events and social support as buffers of life change stress. *Journal of Applied Psychology*. 13;99-125.
- Costa PT. & McCrae RR. (1990) Personality disorders and the five factor model of personality. *Journal of Personality Disorders*. 4;362-371.

- Cowie CC & Eberhardt MS. (1995) Sociodemographic characteristics of persons with diabetes. In: National Diabetes Data Group. *Diabetes in America*, 2nd ed. Washington, DC: National Institutes of Health, National Institute of Diabetes and Digestive and Kidney Diseases, 85-116.
- Curtis JP, et al. (2003) The association of left ventricular ejection fraction, mortality, and cause of death in stable outpatients with heart failure. *Journal of the American College of Cardiology*. 42;736-742.
- Deshotels A. (1995) Gender differences in perception of quality of life in cardiac rehabilitation patients. *Journal of Cardiopulmonary Rehabilitation*. 15:143-148.
- Dylewicz P, et. al. (2000) Beneficial effect of short term endurance training on glucose metabolism during rehabilitation after coronary bypass surgery. *Chest*. 117;47-51.
- Egede LE, et.al. (2002) Modifiable cardiovascular risk factors in adults with diabetes. *Archives of Internal Medicine*. 162;427-433.
- Egede LE. (2004) Diabetes, major depression, and functional disability among US adults. *Diabetes Care*. 27;421-428.
- Evenson KR & Fleury J. (2000) Barriers to outpatient cardiac rehabilitation participation and adherence. *Journal of Cardiopulmonary Rehabilitation*. 20;4:241-246.
- Eyre H, (2004) Preventing cancer, cardiovascular disease and diabetes. *Diabetes Care*. 27;7:1812-1824.
- Flaherty JD. (2005) Diabetes and Coronary Revascularization. *JAMA*. 293:1501-1508.
- Ford ES, et.al. (2008) Trends in A1C concentrations among U.S. adults diagnosed with Diabetes from 1999-2004. *Diabetes Care*. 31;1:102-103.
- Fox CS, et.al. (2004) Trends in cardiovascular complications of diabetes. *JAMA*. 2004;292:2495– 2499.
- Garon JE. (2004) Patient Safety and the preanalytic phase of testing. *Clinical Leadership and Management Review*. 18:6:322-327.
- George PB, et. al. (2001) Treatment of cardiac risk factors in diabetic patients: how well do we follow the guidelines. *American Heart Journal*. 142;857-856.
- Gregg EW, et. al. (2000) Diabetes and physical disability among older US adults. *Diabetes Care*. 23;1272-1277.
- Gregg EW, et al. (2002) Diabetes and incidence of functional disability in older women. *Diabetes Care*. 25;61-67.
- Grundy SM, et.al. (2002) Prevention Conference VI: diabetes and cardiovascular disease: executive summary: Conference proceeding for healthcare professionals from a special writing group of the American Heart Association. *Chest*. 105; 2231-2239.

- Gu K, et.al. (1999) Diabetes and decline in heart disease mortality in US adults. *JAMA*. 281;1291-1297.
- Haffner SM. (2003) Insulin Resistance, inflammation and the prediabetic state. *American Journal of Cardiology*. 92;suppl:18J-26J.
- Hindman L, et.al. (2005) Clinical profile and outcomes of diabetic and nondiabetic patients in cardiac rehabilitation. *American Heart Journal*.150;1046-1051.
- Huang CY, et.al. (2008) The impact of learned resourcefulness on quality of life in type 2 diabetics: a cross-sectional correlational study. *Journal of Nursing Research*. 16;4:264-273.
- Hurst JW. (2006) The value of using the entire New York Heart Association's Classification of heart and vascular disease. *Clinical Cardiology*. 29;4115-417.
- International Diabetes Federation. (2009). The economical burden of diabetes. Retrieved from <http://www.diabetesatlas.org> on September 13, 2010.
- Jette AM. (1980) The Functional Status Index: reliability of a chronic disease evaluation instrument. *Archives of Physical Medicine Rehabilitation*.61;395-401.
- Julien J. (1997) Cardiac complications in non-insulin dependent diabetes mellitus. *Journal of Diabetes and its Complications*.11;2:123-130.
- Kennedy L & Herman WH. (2005) Glycosylated Hemoglobin Assessment in Clinical Practice :comparison of the A1cNow™ point-of-care testing. *Diabetes Technology & Therapeutics*. 7; 907-912.
- Koenigsberg MR, et.al. (2004) Facilitating treatment adherence with lifestyle changes in diabetes. *American Family Physician*. 69;309-316.
- Lavie CJ, et.al. (2005) Cardiac rehabilitation and exercise training programs in metabolic syndrome and diabetes. *Cardiac Rehabilitation and Exercise Training*. 25;59-66.
- Little RR. (2005) Point-of-care testing for glycosylated hemoglobin(GHB). *Diabetes Technology & Therapeutics*.7;913-915.
- Loimaala A, et. al. (2003) Exercise Training improves baroreflex sensitivity in type 2 diabetes. *Diabetes*. 52;1837-1842.
- Maniar S, et.al. (2009) Comparison of baseline characteristics and outcomes in younger and older patients completing cardiac rehabilitation. *Journal of Cardiopulmonary Rehabilitation and Prevention*.29:220-229.
- Mayo Clinic. (2010) Cardiac rehabilitation: an underused resource for women with heart disease. *Mayo Clinic Healthsource*. 8:4-5.
- Mayfield JA, et.al. (1999) Work Disability, and Diabetes. *Diabetes Care*. 22; 1105-1109.

- Mehler PS, et. al.(2003) Lack of improvement in the treatment of hyperlipidemia among with type 2 diabetes. *American Journal of Medicine*.114;377-382.
- Milani RV, et.al. (1996) Behavioral differences and effects of cardiac rehabilitation in diabetic patients following cardiac events. *American Journal of Medicine*.100;517-523.
- Milicevic Z, et.al. (2008) Natural history of cardiovascular disease in patients with diabetes. *Diabetes Care*. 31(Suppl 2);S155-S160.
- Molloy GJ, et.al. (2008) Practical support predicts medication and attendance at cardiac rehabilitation following acute coronary syndrome. *Journal of Psychosomatic Research*. 65;581-586.
- Morisky DE, et.al. (1986) Concurrent and predictive validity of a self-reported measure of medication adherence. *Medical Care*. 24;67-74.
- Mourot L. et.al. (2010) Cardiovascular rehabilitation in patients with diabetes. *Journal of Cardiopulmonary Rehabilitation and Prevention*. 30:157-164.
- National Center for Chronic Disease Prevention and Health. (2008) Leading Health Indicators. Retrieved from <http://www.healthypeople.gov>, on July 12, 2008.
- National Center for Chronic Disease Prevention and Health. (2009).Healthy People 2020 Public Meetings 2009 Draft Objectives. Retrieved from <http://www.healthypeople.gov/HP2020/> on September 13, 2010.
- National Center for Health Statistics. *Diabetes Statistics*. (2008). Retrieved from <http://www.cdc.gov/nchs/fastats/diabetes.htm> on February 22,2009.
- Pennell L, et. al. (2005) Practice changes in glycemic management and outcomes in coronary artery bypass surgery patients. *Journal of Cardiovascular Nursing*.20;1:26-34.
- Poulsen MK, et.al.(2010) Left ventricular diastolic function in Type 2 Diabetes Mellitus. *Circulation*.3;24-31.
- Renders CM, et.al. (2001) Interventions to improve the management of diabetes mellitus in primary care, outpatient and community settings. *Cochrane Database of Systematic Reviews*1:CD001481.
- Rachmani R, et.al. (2002) Teaching patients to monitor their risk factors retards the progression of vascular complication in high-risk patients with type 2 diabetes mellitus-a randomized prospective study. *Diabetes Medicine*. 19;385-392.
- Rigby D. (2007) Adherence assessment tools: Drugs don't work when they-re not taken. *Australian Journal of Pharmacy*.88;32-22.
- Rosano GM. (2006) Metabolic therapy for patients with diabetes mellitus and coronary artery disease. *American Journal of Cardiology*. 98;suppl:14J-18J.

- Sahakyan K, et.al. (2006) Comparison of functional status after coronary artery bypass grafting in patients with and without diabetes mellitus. *American Journal Cardiology*. 98;619-623.
- Sanderson BK, et.al. (2010) Cardiac rehabilitation and women. *Journal of Cardiopulmonary Rehabilitation and Prevention*. 30;12-21.
- Saydah S, et.al. (2004) Poor control of risk factors for vascular disease among adults with previously diagnosed diabetes. *JAMA*.291;335-342.
- Sigal RJ, et. al. (2007) Effects of aerobic training, resistance training, or both on glycemic control in type 2 diabetes. *Annals of Internal Medicine*.147;357-369.
- Soja AM, et. al.(2007) Use of intensified comprehensive cardiac rehabilitation to improve risk factor control in patients with type 2 diabetes mellitus or impaired glucose tolerance-the randomized DANish StUdy of impaired glucose metabolism in the settings of cardiac rehabilitation (DANSUK) study. *American Heart Journal*. 153;621-628.
- Songer TJ. (1998) Studies on the Costs of Diabetes. Atlanta, GA: Centers for Disease Control and Prevention; Division of Diabetes Translation.259-282.
- Suls J. (1989) The relation between type a behavior and chronic emotional distress: a meta-analysis. *Journal of Personality and Social Psychology*. 57;3:503-512.
- Suresh V, et.al. (2001) Standard cardiac rehabilitation is less effective for diabetics. *International Journal of Cardiac Practice*. 55;7:445-448.
- Tekin G, et.al.(2006) Simvastatin improves attenuated heart rate recovery of type 2 diabetics. *Pharmacological Research*.54;442-446.
- The Criteria Committee of the New York Heart Association. (1994) *Nomenclature and Criteria for Diagnosis of Diseases of the Heart and Great Vessels*. 9th ed. Boston, Mass: Little, Brown & Co.
- U.S. Department of Health and Human Services. (2008) Diabetes, Disabling Disease to Double by 2050. *Centers for Disease Control and Prevention; Coordinating Center for Health Promotion*. 1;1-4.
- U.S. Department of Health and Human Services. (2009)*The Seventh Report of the Joint National Committee on Prevention, Detection, Evaluation, and Treatment of High Blood*. <http://www.nhlbi.nih.gov/guidelines/hypertension>.accessed February 22, 2009.
- Wallston KA. Stein MJ. Smith CA. (1994) Form C of the MHLC scales: a condition-specific measure of locus of control. *Journal of Personality Assessment*. 63;534-553.
- Wiebe JS. et.al.(1997) Health beliefs, personality, and adherence in hemodialysis patients: an interactional perspective. *Annals of Behavioral Medicine*. 19;30-35.
- Wishner KL. (1996) Diabetes mellitus: its impact on women. *Int J Fertil* 41;177-86.

- Woodgate J. & Brawley LR. (2008) Self-efficacy for exercise in cardiac rehabilitation. *Journal of Health Psychology*. 13;3:366-387.
- Wu SF, et al. (2008) Psychometric properties of the Chinese version of the Perceived Therapeutic Efficacy Scale. *Journal of the Formosan Medical Association*. 107;232-238.
- Verges B, et.al. (2004) Effects of cardiac rehabilitation on exercise capacity in type 2 diabetic patients with coronary artery disease. *Diabetic Medicine*.21; 889-895.
- Völler H, et.al. (2009) Secondary prevention of diabetic patients with coronary artery disease in cardiac rehabilitation: risk factors, treatment and target level attainment. *Current Medical Research and Opinions*.25;879-890.
- Von Korf M, et.al. (2005) Work disability among individuals with diabetes. *Diabetes Care*. 28;1326-1332.
- Yu C, et. al. (2000) Clinical predictors of morbidity and mortality in patients with myocardial infarction or revascularization who underwent cardiac rehabilitation, and importance of diabetes mellitus and exercise capacity. *American Journal of Cardiology*.85;344-349